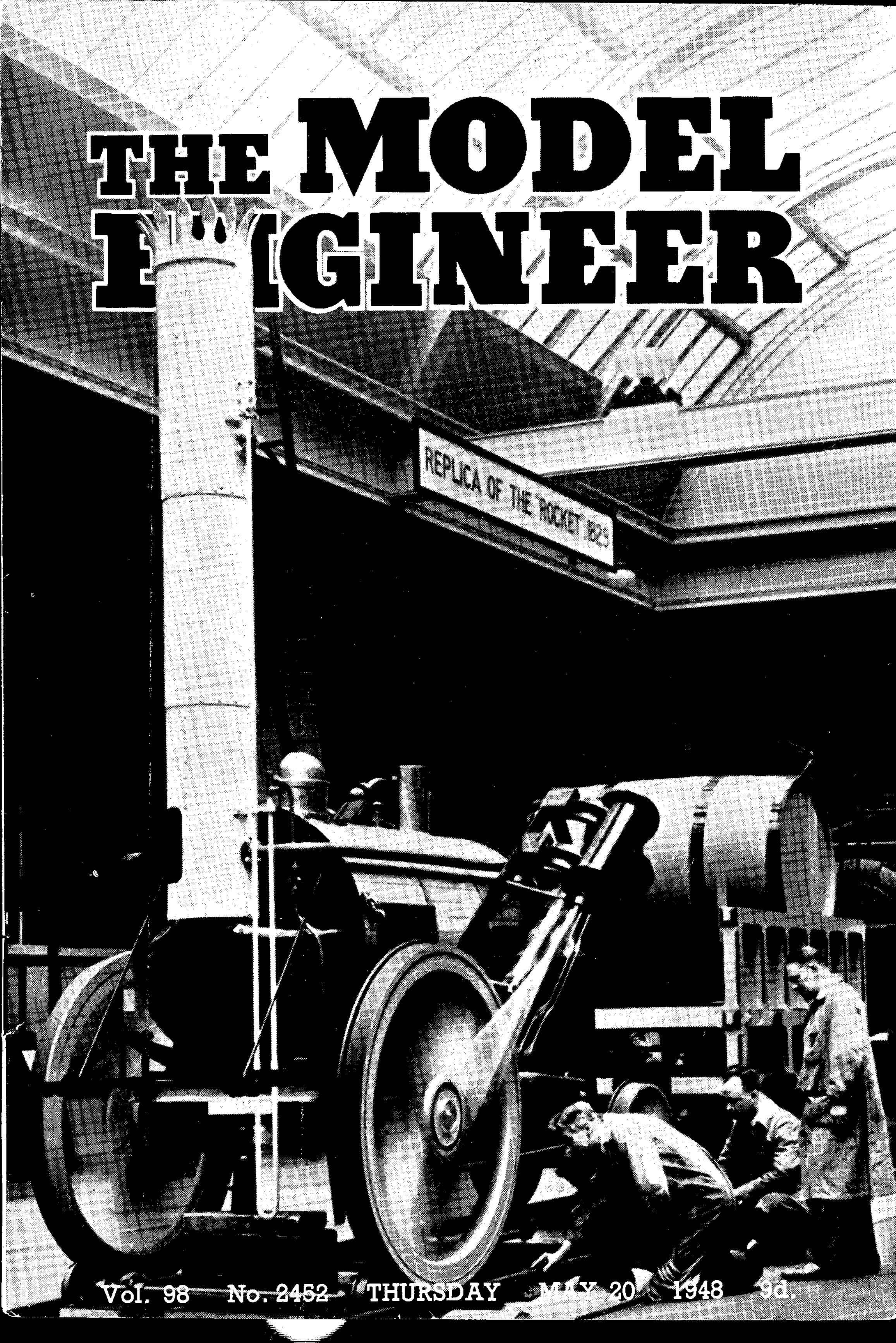
THE MODEL ENGINEER



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The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, *GREAT QUEEN ST.*, *LONDON*, *W.C.*2

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SMOKE RINGS

Our Cover Picture

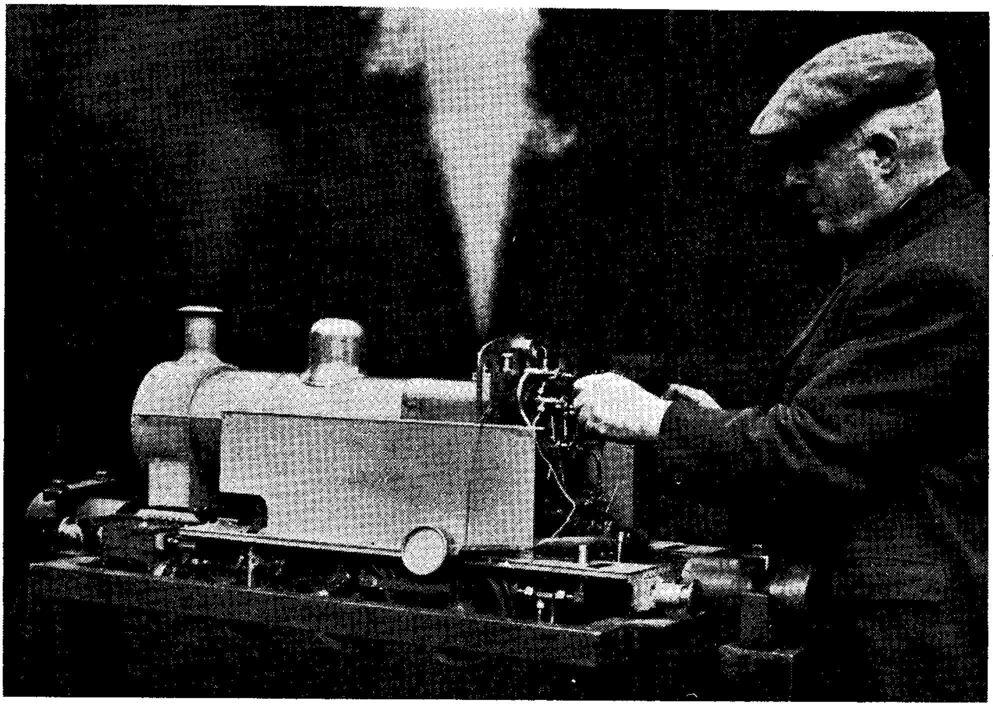
● ONE OF the most interesting model locomotives ever built is the full-size replica of the *Rocket* constructed by Robt. Stephenson & Co. in 1929 for the late Henry Ford; it is complete in all details and can be steamed. When it was completed, Stephenson's built another, differing from the previous one in being half-sectioned to show the internal arrangements. This second model is the subject of our cover picture; it is in the Science Museum, South Kensington, and stands with its wheels just clear of the track, bearing against electrically-operated rollers. When these rollers are revolved, the *Rocket's* wheels also revolve, and all the moving parts of the engine are set in motion so that the functions of each part can be clearly observed and studied. Our picture shows museum officials testing the apparatus.—J.N.M.

Interchange of Locomotives

● I MUST offer an apology to the Southern 4-6-2 locomotive for what I wrote about her in my first note on these most interesting trials. There may be some quite satisfactory explanation of the display of slipping which was apparent when I saw her first departure on the 1.30 p.m. train from Paddington. I saw her again during the following week, and must say that the departure was excellent; there was no slipping this time. Further, the engine has improved on schedule in both directions. The famous *Mallard* of the Eastern region met very bad luck on her first "up" trip; she ran well on the "down" trip the previous day, and duly impressed everybody concerned. On the return journey, however, she gained so easily on the booked times that she was seven minutes early at Savernake; then she had the misfortune to suffer the failure of the inside big-end bearing, and had to retire from the contest. She was replaced by a sister engine, No. 60033, *Seagull*, which I saw make a splendid start from Paddington the following day. I have seen the Midland Region "Royal Scot" class engine No. 46162, *Queen's Westminster Rifleman*, leave Kings Cross on the 1.10 p.m. express to Leeds; she managed it in splendid style and, I understand, has done very well indeed throughout her tests. At the moment of writing, the tests show "little in it," so far as performance is concerned.—J.N.M.

A Useful Contrivance

● THE PHOTOGRAPH reproduced here shows Mr. W. D. Hollings, Secretary of the West Riding Small Locomotive Society, giving his $1\frac{1}{2}$-in. scale L.M.S. 0-6-0 Dockyard tank engine a stationary steam test. The engine is mounted on a sort of movable crate which is on runners, so that the whole contrivance can be easily moved about as desired. The device also permits the engine to be revolved, on a longitudinal axis, into any position required for examination and adjustment when not in steam. The large pressure-gauge seen in the photograph is used so that its reading can be compared with that of the small gauge fitted on the front weatherboard, and to ensure that the small gauge gives correct readings. Mr. Hollings hopes to have his engine finished and painted in time for it to be entered at the forthcoming MODEL ENGINEER Exhibition next August.—J.N.M.

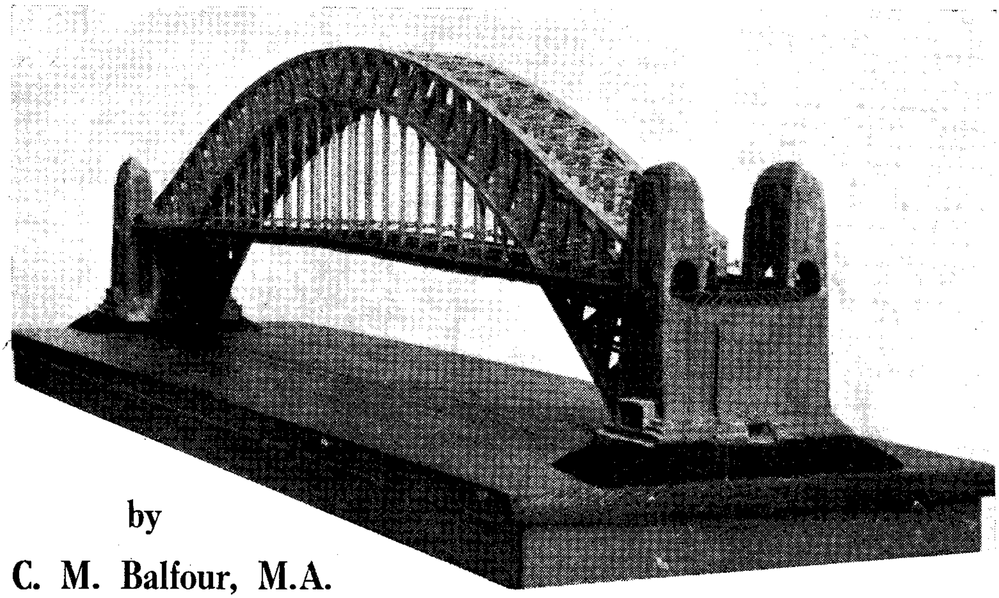


W. D. Hollings raising steam on his model dockyard tank engine

Silencing Model I.C. Engines

● THIS IS a problem which has often been discussed in THE MODEL ENGINEER in the past, but renewed attention has recently been focused on it due to the increasing noisiness of model high performance engines and the urgent need for avoiding annoyance to the public when these engines are run in a park or built-up areas. The subject is one which bristles with difficulties, but I think that the lead taken by the Model Power Boat Association at this year's annual general meeting to encourage the adoption of silencing measures on model power boat engines, is a very wise one, and worthy of being followed by other organisations which deal with the running of small i.c. engines. Competitors in racing events are quite naturally reluctant to adopt any measures which might possibly handicap their chances of success, or increase weight or complication, and organisers of these events will probably find a good deal of opposition to any attempt to make silencing universally compulsory; but much can be done to direct attention to this problem by special competitions in which silencing is a scoring factor. My own experience has shown that it is possible to reduce the noise produced by most types of i.c. engines without undue decrease of power, and although there are some types of engines which cannot be silenced without seriously interfering with efficiency, the investigation as to which types of engines can or cannot be dealt with in this way would be by no means in vain. There is more than a mere possibility that, in some cases, users of these engines may be forced to take the choice between either producing quieter engines or having imposed on them a still more profound silence, by the complete banning of these engines in public places. One may feel that sometimes, the complaints made in respect of the noise produced by the engines, are somewhat exaggerated, in view of the amount of noise which is tolerated in modern civilised life; but all model engineers are good citizens and will be anxious to avoid any possible grounds for being regarded as public nuisances.—E.T.W.

Model of Sydney Harbour Bridge



by

C. M. Balfour, M.A.

THIS model is built of scrap tinplate and wire of two sizes taken from stranded cables. The scale of 1 in 500 was followed as closely as possible throughout, except for the main chords; their depth was increased by about one quarter for fear of undue weakness in erection. The scale was suggested by the sizes of the wires, 0.016 in. and 0.008 in. diameter, used to represent 8 in. × 8 in. and 4½ in. × 4 in. angles used in the original. The span of the model is 3 ft. 3½ in., height above abutments 10 in. and width across chords 2¾ in.

The main chords are box girders 0.35 in. wide and 0.11 in. deep; the bottom chord increasing uniformly in depth from the centre to 0.25 in. at the abutments. They are built up of small pieces one panel long, and each chord consists of two webs and two cover plates. Soldered to the webs are channel sections bent up in a special fixture over the edge of a strip of 14-gauge plate, with their flanges filed down and gauged to 0.025 in. deep. These represent the 12-in. flanges of the original. Cover plates and channels break joint at the panel points, and webs midway between, giving a good overlap.

Posts and diagonals each consist of two box girders connected by cover plates at the ends, and in some cases in the middle. Each girder is built up of two standard channels, as used in the top chord, set back to back for posts and face to face for diagonals, and connected by lattice bracing. The channels were set up on edge in a jig, consisting of pins driven into a board and the bracing wires put on, as in the original. These are arranged in Vs on diagonals and Xs on posts. A length of fine wire 0.008 in. diameter, cleaned and tinned, was tacked at one end across the edges of the channels at the correct angle, and the free end cut off flush with a pair of retired nail scissors. This was repeated all along the member on both sides.

The two sides of the arch were built up lying flat on a board with pins forming a jig, before starting the lateral bracing. Laterals are box girders built up of four 0.016-in. wires, with lattice bracing on all four sides, and cover plates at the ends and centre. They were built in halves. Starting with three L-shaped plates, 0.11-in. arms, set out at the proper spacing, two wires were tacked across them, and connected between the plates by V-lattice bracing of 0.008-in. wire. Then two of these assemblies were connected together in a pin jig by X-type bracing.

Lateral diagonals, as in the original, were built in three parts, one continuous across the bridge, and two half-lengths butting to it at the centre. The centre joint was made by fitting small X-shaped cover plates top and bottom. Construction was as for laterals, but was complicated by the member being deeper at the centre than at the ends.

Deck bearers and bracing follow the original fairly closely, the bracing system of laterals and diagonals being made in the same way as the arch laterals.

The pylons were of wood coated with "Pyruma" cement. A small press tool was made to imitate the masonry, and other details were worked up with a pen-knife blade.

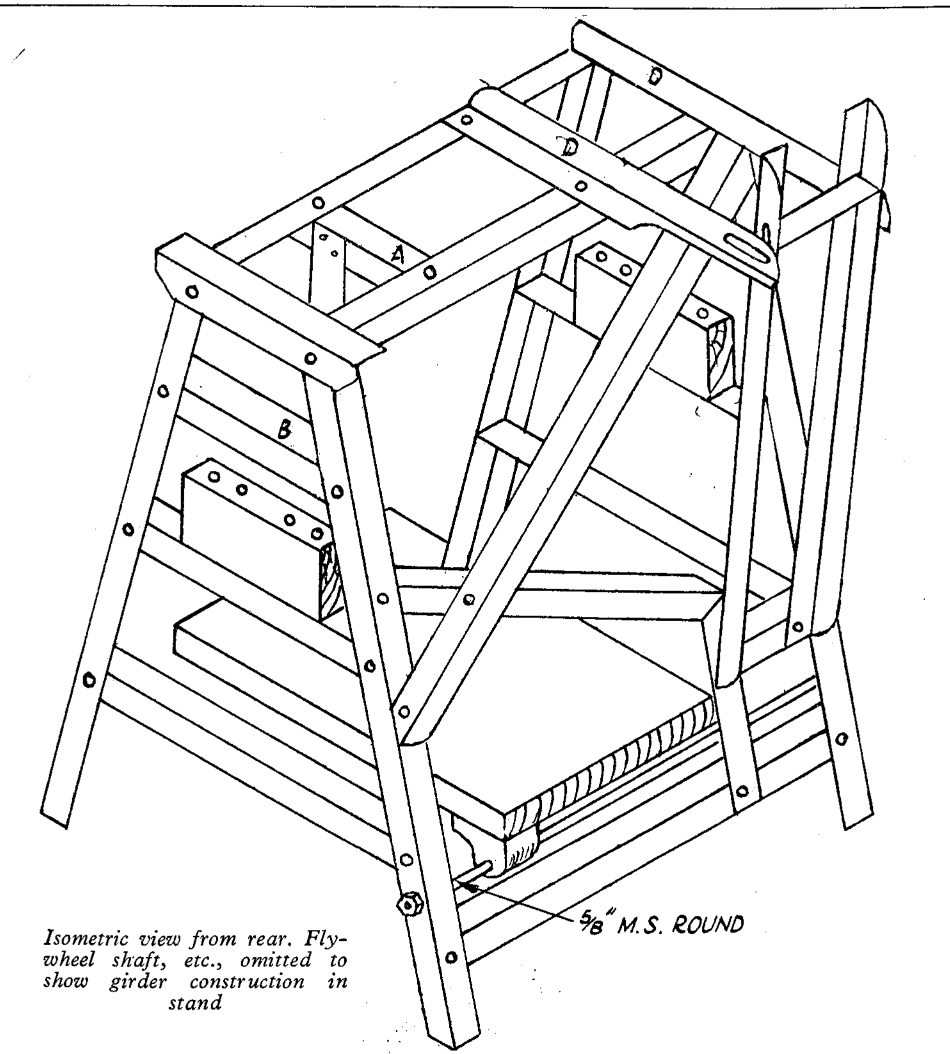
This work was started in September, 1939, and occupied spare time during the war years very agreeably. Only the simplest hand tools were needed and most of the work was done in an armchair.

A Simple Treadle Stand

by H. E. Birkett

THIS treadle stand was made to drive a lathe which was to be acquired when the opportunity arose and when my finances were strong enough to bear the cost. It was started in 1939, but the war interrupted the construction. After the war, the treadle stand was completed, and a treadle itself, which were drilled on a hand-bench drill.

The materials used are those which can be obtained from any cycle spares shop or garage. The framework is made from the side girders from old, tubular-ended, steel bedsteads. The



Isometric view from rear. Flywheel shaft, etc., omitted to show girder construction in stand

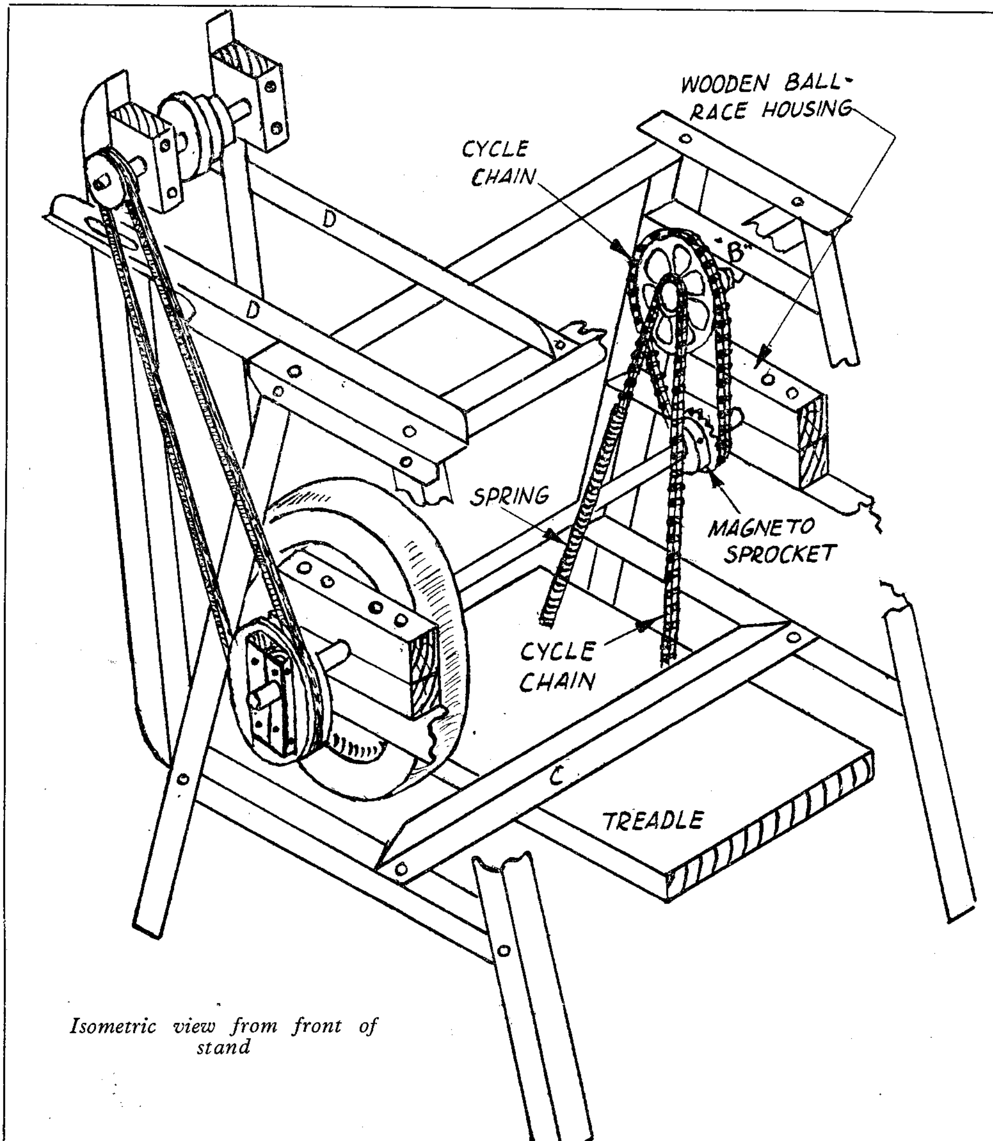
4-in. Drummond R.B. lathe, bought through the help of a model engineer friend at a reasonable price, was found to fit the length of the stand almost exactly.

It was constructed without the use of machine tools, with the exception of the bearings for the flywheel, axle shaft and bearings were obtained from a garage for 10s., and are all used car parts, the shaft being a half back axle, with ball-races from another but slightly smaller axle. Other items used are: A cycle back-wheel hub a large cycle sprocket-wheel without pedal,

and a magneto sprocket-wheel with 16 teeth.

The construction of the two "A"-shaped frames, shown in the sketches, was tackled first, and some time and energy was spent in hack-sawing the girders to length, and drilling the $\frac{3}{8}$-in. bolt holes. The holes were drilled by hand, using a small hand-brace and $\frac{1}{8}$-in. drill to drill a pilot long, and the "A" frames are 2 ft. wide at the floor and 8 in. across the corner girder at the top.

As the largest flywheel which I could obtain cheaply was only 14 in. diameter, I decided to gear up the speed of the flywheel by means of the cycle-hub countershaft and chain in the hope of obtaining a smoother drive to the lathe.

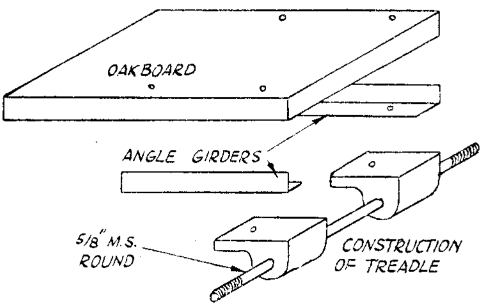


Isometric view from front of stand

hole. Then the holes were opened out, with three sizes of drills, in a joiner's brace, to the bolt size of $\frac{3}{8}$ in. From the two isometric back and front views it will be seen that one "A" frame has an extra girder, "B," to hold one end of the cycle hub countershaft. Incidentally, the treadle stand is approximately 2 ft. 8 in. high and 2 ft.

After the two ends were completed, a change of plan was decided on. This was to cut out the idea of the customary direct drive from flywheel shaft to the lathe cone pulley. Instead, a countershaft on a hinged frame was planned, so that an electric motor could be mounted on the back of the countershaft frame to drive the lathe through the

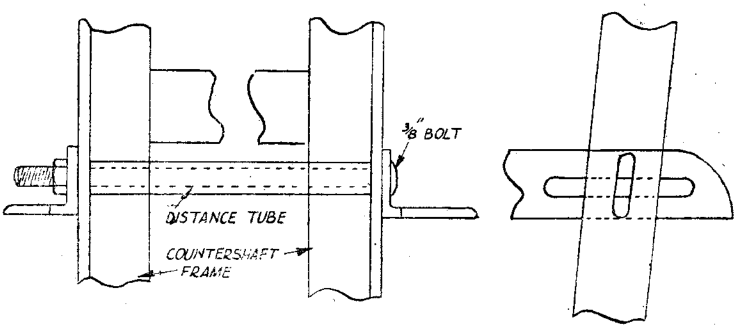
same countershaft as the treadle. Thus, by changing the pulley on the end of the countershaft, the lathe can be driven either from the treadle or from the motor, using the same length of belt. The wooden pulleys have been tapped and screwed up against a shoulder on the countershaft, an arrangement which may seem crude, but which has worked well during the past two years.



By unscrewing one pulley, screwing on the other, and changing over the belt, a quick change can be made from treadle drive to motor drive, or the reverse.

After the "A" frames were made, three 2-ft. length girders were sawn, drilled and bolted in position, and a length of $\frac{5}{8}$-in. mild-steel rod, threaded at both ends and provided with four nuts, was bolted to the "A" frames in the position shown in sketch. The treadle was next taken in hand, and two iron castings, as shown in the sketch, were obtained from a pattern I made. These were drilled for the $\frac{5}{8}$-in. rod and a $\frac{3}{8}$-in. bolt. Two lengths of bed girder were sawn and drilled and the girders, oak board and castings, were bolted together to complete the treadle, which was hinged on the $\frac{5}{8}$-in. rod. A length of girder, "C," acts as a stop for the "up" position of the treadle and blocks of rubber screwed to the underside of the oak board help to soften the shock when the treadle touches the floor in the "down" position. At this point, the war intervened, and construction ceased until 1946. After the war, work on the treadle stand was resumed, and a flywheel, a 1 in. length of axle shaft, and two ball-races were obtained from a garage. The ball races were fitted to the shaft by drawfiling the ends of the shaft until the races were a tight push fit. These races were fitted into the two housings, which were each made from two pieces of beech, one 8 in. × $1\frac{1}{2}$ in. square and the other 8 in. × $1\frac{1}{2}$ in. × $2\frac{1}{2}$ in. The pieces were first bolted together with $\frac{3}{8}$-in. coach bolts, i.e. the type of bolt which has a rounded head with a square underneath the head and a square nut. Circles to suit the size of the ball-races were then marked on the side of the wooden housing and a clearance hole for the shaft was bored. The recess for the ball-race was cut out of each piece of the housing by careful chiselling and gouging. The two halves of the housing were then bolted together, and the complete housings hold the ball-races tightly enough to prevent the race from turning in the housing. Two holes were bored through the housings for the holding-down bolts to the girder frame.

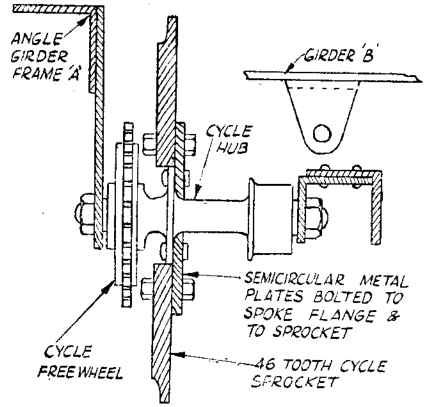
The next job tackled was the mounting of the flywheel on to the shaft. This was done by making two clamps, each of two pieces of wood, of a length to suit the diameter of the flywheel, and $1\frac{1}{2}$ in. square. These pieces were bolted together in pairs, and a circle marked in the middle of the length of each pair to suit the shaft diameter. The two pieces were then unbolted, and the semi-circular shape in each piece was cut out with the gouge. The completed clamps were then bolted on to the shaft and checked with a try-square. As the hole in the flywheel was approximately 4 in. in diameter, a circular centre-piece of wood of the same thickness as the web of the flywheel was fitted, and a centre hole was bored for the shaft. The flywheel was then mounted on the shaft, and the two wooden clamps were bolted to the flywheel, one on each side, and at 90 deg. to each other, as shown in the sketch. It was found that the flywheel ran very smoothly in the ball-races, and, considering the somewhat crude mounting, with only a small inaccuracy. A $\frac{1}{4}$-in. key-way was cut by hand in the shaft and the centre hole of the magneto sprocket was filed out to be a tight fit on the shaft. After cutting a key-way in the sprocket, it was driven into position, and it stayed in this state for some time after the treadle was put to use. Later, a 1-in. thick disc of steel was bored to suit the shaft and keyed to it. A set-screw holds the disc in place, and two bolts hold the sprocket to the disc.



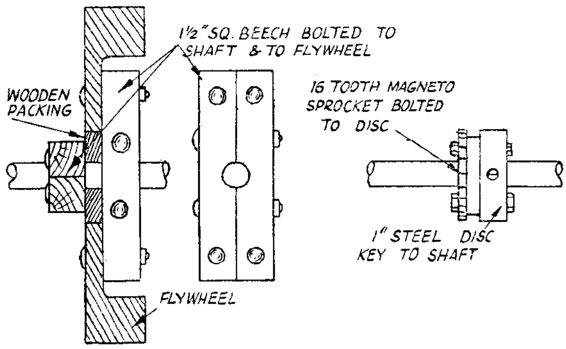
Countershaft frame: adjustment and locking

The cycle hub, large sprocket, free-wheel and two cycle chains were obtained next. It was found that the centre hole of the sprocket needed only a little enlarging to fit over the spoke flange of the hub and this was carefully done with the file. Two semi-circular pieces of $\frac{3}{16}$-in. metal were shaped up, and a semi-circular hole was cut in the centre of the flat side of each piece, so that the two pieces would form a circle around the

centre part of the hub. The circle of metal was bolted to the spoke flange with $\frac{3}{16}$-in. bolts, through enlarged spoke holes. The sprocket was then bolted to the metal disc so that it was mounted on the edge of the spoke flange. The free-wheel was screwed on to the hub and the complete unit was attached to girders "A" and "B," as in sketches. A length of cycle chain connects the large sprocket and the magneto sprocket on the flywheel shaft. Another chain, in speed from 1,425 r.p.m. to approximately 350 r.p.m. is obtained, and a 3-in. pulley for use with the treadle. The pulley on the end of the flywheel shaft was sawn from 1-in. thick beech roughly to size, 7 in. diameter. It was then bored for the shaft, placed in position, and fixed by a split wooden clamp in the same way as the flywheel. A hand-rest for wood turning was improvised and with the assistance of a boy to work the treadle and one or two home-made wood-



Cycle hub countershaft—construction and mounting



Flywheel and magneto sprocket mounting

running over the free-wheel, is attached to the treadle at one end, and to the long expansion spring (obtained from an old easy chair) and treadle at the other. Pressure on the treadle causes the chain to pull round the free-wheel and sprocket wheel unit which, in turn, drives the flywheel shaft approximately three times faster. When the pressure on the treadle is released, the spring pulls the treadle up into position in readiness for the next downward pressure. It was found that the treadle worked easily and well, so the construction of the countershaft frame was started.

The frame consists of four pieces of bed girder bolted together, and is $2\frac{1}{4}$ in. $\times$ $7\frac{1}{4}$ in. A large steel butt hinge was bolted to the treadle stand frame, and to the bottom girder of the countershaft frame. Two pieces of angle girder, "D" in sketch, 2 ft. long, bolted to the main frame and slotted at the ends, steady the countershaft frame, but allow it to move towards the lathe for changing over the belt on the cone pulleys to obtain different speeds. A long bolt passes through the slots in the steady girders "D" and the countershaft frame, with a length of tube on the bolt between the sides of the countershaft frame side girders. This bolt holds the frame against the pull of the belt, and the nut and spanner locking has since been replaced by a locking handle.

The $\frac{3}{4}$-in. countershaft itself runs in second-hand car ball-races mounted in wooden housings, bolted to the countershaft frame, in a similar manner to the bearings of the flywheel shaft. The end of the countershaft is threaded, and the wooden pulleys can be easily screwed on or off the shaft. There are two pulleys, a 9-in. pulley for use with the electric motor, when a reduction

turning tools, the pulley was turned in position on the shaft, and the groove turned to suit a standard $\frac{1}{2}$-in. vee belt.

About this time a Drummond 4-in. R.B. lathe was acquired and mounted on the treadle. I decided to change the flat belt cone pulley for a $\frac{1}{2}$-in. vee belt type, and after hunting around a few shops I was lucky enough to pick up two Myford type cone pulleys, one with a $\frac{3}{4}$-in. hole for the countershaft and one with a 1-in. hole which, by a lucky coincidence, exactly fitted the mandrel on the Drummond lathe. The mandrel pulley had a gear-wheel attached to it, which later led me to fit the lathe with a back gear. After fitting the two vee belt cone pulleys the lathe was ready for use.

One of the first jobs to be tackled was the turning and boring of the steel disc to hold the magneto sprocket; the job was finished without mishap, and a start has been made on "L.B.S.C.'s" "*Olympiade*."

A Use for Old Electric Fire Elements

Amateurs may like to know that old nickel-chrome resistance wire removed from damaged or defective fire elements makes excellent binding wire for joints which require securing for silver-soldering. The heavy oxide on the wire prevents any tendency for the silver-solder to adhere to it, and its high heat resisting qualities prevent it melting or burning away under the heat of the blowlamp, which often happens with soft-iron binding wire.—R. N. J. EDMONDS.

Link Motion for "Maid of Kent"
by "L.B.S.C."

THE full-sized "L1" class on the Southern Railway had Stephenson link-motion of the "indirect" type; that is, the movement of the die-blocks was communicated to the valve-spindles by means of rocking levers. Our little "Maid" has similar valve-gear, but with two important differences. One is, that it is simplified by having the die-block attached directly to the rocking lever, eliminating the intermediate valve-rod and suspension levers of the big engine; the second is the provision of a hand-operated reverse, either by "pole" lever or wheel and screw, as desired. Instead of the power reverser, which looked like a Westinghouse donkey-pump, as the steam and cataract cylinders were arranged vertically, with a direct connection to a weighbar-shaft, below the motion, we use the ordinary weighbar-shaft above the motion, and connect it to the hand gear in the cab in the usual way by a long reversing-rod, or reach-rod as it is sometimes called. The full-sized "Minx" had this arrangement, so we can fairly claim to "share favours"! The same layout will do for the "Minx," but as she has different wheel spacing, being an 0-6-0, the eccentric-rods will have to be just a little longer, and the radius of the link altered to suit. To prevent any beginners going astray, I propose, all being well, to give a separate drawing, and also note the difference in the motion-plate which is necessitated by the "Minx's" single overhead guide-bar. So much for generalities; now to business.

Motion-Plate

A casting will be available for this, and shouldn't require much doing to it, if reasonably clean. The ends should be milled off to fit between the frames, same as described for the frame stay; if no means of machining are available, use a file, and apply a try-square to get the sides at right-angles to top and bottom. Aim for an exact fit, so that the frames shall not be forced outwards to get the motion-plate erected, nor pinched in when the fixing-screws are tightened. The openings for the ends of the guide-bars are easily cleaned up with a file, and the lugs smoothed off at the same time. Drill them No. 30. The cast-on brackets for carrying the rocking levers should, if possible, be milled off each side; and if you have a side-and-face cutter of the usual type, it could be done in the lathe. Mount the cutter on a spindle between centres; hold the motion-plate, brackets pointing skyward, in a machine-vice (regular or improvised) attached to the lathe saddle, and traverse under the cutter. One setting-up does for all four sides, as the whole issue can, of course, be moved along the lathe bed to bring each side of each bracket into correct position for cleaning-up. If you have no cutter, and there is no chance of doing the job on somebody else's milling-machine, you'll just have to fall back on the file once again. "Needs must—" you know the old saying!

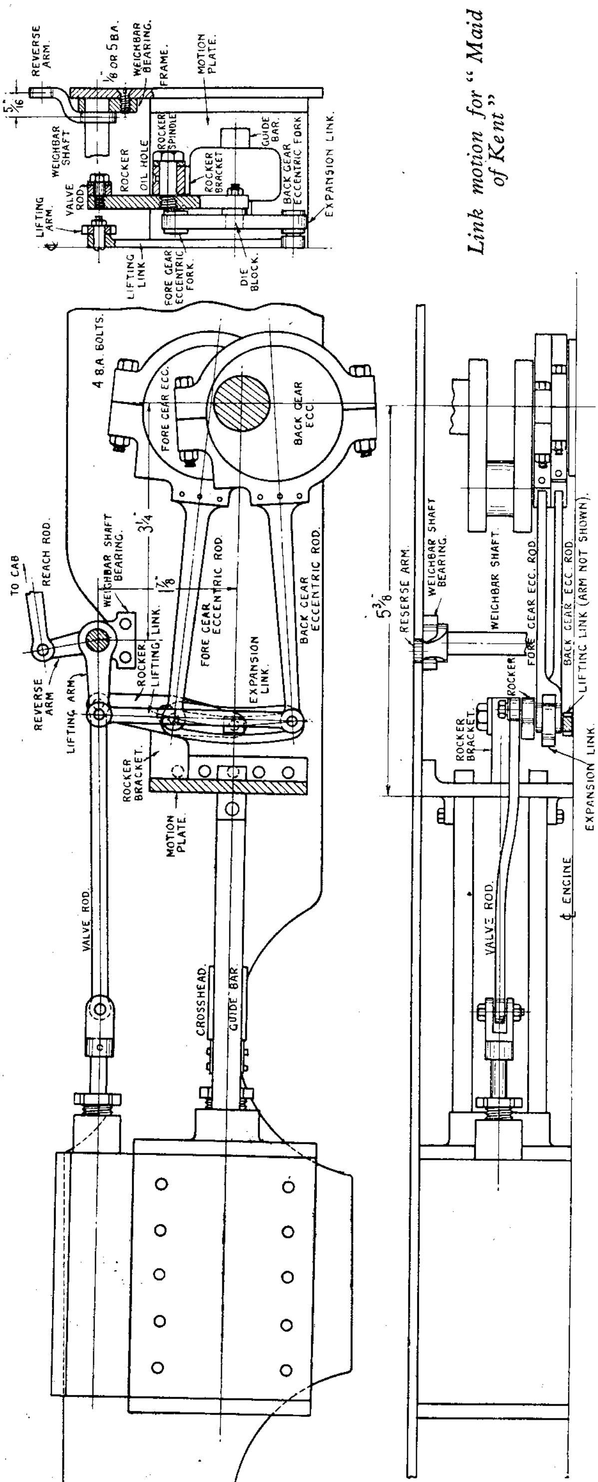
Be mighty careful when marking out the holes for the rocker fulcrum pins in the brackets. If you haven't a drilling-machine, use the lathe to drill the holes; put a $\frac{1}{8}$-in. drill in the three-jaw, place one of the centre-popped brackets against it, then bring up the tailstock centre and put the point in the centre-pop in the other bracket. Turning the hand-wheel will send the drill through the bracket. Reverse the plate and repeat operations, with the tailstock centre in the hole first drilled. Open out with letter C or 15/64-in. drill by the same process, and then poke a $\frac{1}{4}$-in. parallel reamer through the two at once, so that they can't help being dead in line. The three holes at the bottom are for the bolts holding the feed-pump bracket.

You can't go wrong in erecting the motion-plate, as it automatically locates itself. Disconnect the big-ends, slip the plate over them, rocker brackets pointing to rear of engine, and adjust the plate on the ends of the guide-bars. Set it so that the side of the plate nearest to cylinders, is exactly $5\frac{3}{8}$ in. ahead of the centre of the driving axle. The piston-rod should be fully extended, and the crosshead as close to the plate as possible. Put a cramp over the frame to prevent the plate moving; then run the No. 21 drill through the holes in the frames, making countersinks on the motion-plate flanges; follow up with No. 30, tap 5/32 in. by 40, and put screws in; or use No. 19 drill and 3-B.A. screws.

As they show, hexagon heads can be used, to please Inspector Meticulous; but don't put *all* the screws in yet, as the plate has to come out again. With a bent scriber, mark the guide-bars through the holes in the lugs; and drill and tap the bars for $\frac{1}{8}$-in. or 5-B.A. screws when you have the motion-plate out again. The cylinders will have to be taken out for this purpose, but if you only have two or three screws holding them in place at each side (the full number should never be put in until erecting "for keeps") that won't be any trouble!

Eccentric-straps and Rods

The eccentric-straps should be good bronze castings. Machine up five whilst you are on the job, so that one will be ready for the boiler feed-pump when that component is made and erected. Clean up the outsides with a file, then drill the lugs No. 34. Mark each lug, so that when parted, they can be replaced correctly again (I use a set of $\frac{1}{16}$-in. number punches for jobs like this) then saw across, using the vice top to guide the saw blade. If the saw "cuts rough," smooth off the marks, and bolt the two halves of each strap together by 4-B.A. bolts, which can be made from 7/64-in. silver-steel screwed each end and furnished with nuts. Chuck truly in the four-jaw, bore to a nice running fit on the sheaves or tumblers, face off one side, then reverse and re-chuck on the smallest step of the inside jaws of your three-jaw. Set to run truly, then face the



Link motion for "Maid of Kent"

upturned side until the strap is 7/32 in. wide. The easiest way to form the slot in the lug for the eccentric-rod, is to hold the strap in a machine-vice on the lathe saddle, and run it under a $\frac{1}{8}$-in. circular slotting cutter on a spindle between centres; it may, of course, be planed out with a $\frac{1}{8}$-in. parting-tool if a planer or shaper is available, or end-milled with a $\frac{1}{8}$-in. end-mill or home-made slot drill in the three-jaw, the strap being clamped on its side under the lathe tool-holder, packed up to centre height. Don't forget to drill the oil-hole.

Anybody who has a hefty milling-machine—hefty, that is to say, for the average home workshop—can mill the eccentric-rods out of a piece of $\frac{3}{4}$-in. by $\frac{3}{8}$-in. mild-steel bar; and you'll probably need a wheelbarrow to cart away the swarf! The easiest way is to use a piece of $\frac{3}{4}$-in. by $\frac{1}{8}$-in. mild-steel approximately $3\frac{1}{2}$ in. long, for each rod. Mill or file roughly to shape, then braze a little block of steel about $\frac{5}{16}$ in. square and $\frac{7}{8}$ in. long, on the end. This can be machined up to form the fork or clevis. Beginners, drill the hole through the solid before slotting; then clamp the rod under the slide-rest tool holder, and feed up to a $\frac{3}{16}$-in. slotting cutter on a spindle between centres, or on a stub mandrel held in the three-jaw. Use slow speed and plenty of cutting oil. Little slotting cutters suitable for these jobs are not very expensive to buy, last no end of a time, and can also be home-made; I have described how, several times. The ends can be rounded off with a file, guided by a Wilmot filing-jig or toolmaker's button, which I have also described. For beginners' benefit, chuck a piece of $\frac{5}{16}$-in. silver-steel in the three-jaw, and turn a $\frac{1}{16}$ in. pip on the end, to a push-fit in the hole in the fork. Part-off $\frac{1}{4}$ in. from shoulder. Repeat process, and harden both jigs right out by heating to red and dropping in water. Jam a little bit of $\frac{3}{16}$-in. plate in the fork, put the pips of the jigs in the holes at each side, grip by holding in a bench vice with a jig against each jaw, and file off the surplus until the file touches the jigs.

How to Assemble Straps and Rods

All four eccentric-rods must be exactly the same length between centres of holes in fork, and strap; and to ensure this, assemble on a jig. Once again, for beginners' benefit, get a piece of flat bar, say 1 in. by $\frac{3}{16}$ in. and about 6 in. long. Scribe a line down the middle, set out two points $4\frac{1}{4}$ in. apart, and drill them with No. 24 drill. Ease a bit of 5/32-in. round steel with a file, whilst revolving in the chuck, so that it will just pass the No. 23 hole in the fork on the eccentric-rod,

then cut off about $\frac{3}{4}$ in., further reduce the extreme end until it will squeeze into one of the holes in the flat bar and press it in. Chuck a short bit of 2-in. round bar in the three-jaw (any metal will do, aluminium included) turn about $\frac{1}{2}$ in. of it to the same size as eccentrics, turn a pip on the end to a tight push-fit in the other hole in the bar, and part-off about $\frac{3}{8}$ in. from the shoulder. Press that in too, and the jig is complete. Lay a piece of asbestos sheet on the bar, making holes for the disc and pin to pass; then push the T-end of the eccentric-rod into the slot in the lug, adjusting it until it will lie on the jig with the fork over the pin and the strap over the disc; then soft-solder the joint. Take the lot off the jig, put three 3/32-in. rivets through the joint, countersinking both sides (I use bits of 3/32-in. iron wire) file flush, and also clean off any solder showing outside. If all four assemblies are made up thus on the jig, they *must* be exactly the same length between centres. Don't forget that you need two right-hand and two left-hand gadgets; that is, when the oil-holes are at the top, two forks must offset to the right of the rods, and two to the left. You can see the reason for this by taking a look at the plan view of half the motion.

Expansion-links

The best materials to use for making the expansion-links, is $\frac{3}{16}$-in. "ground flat stock," which is a fine grade of cast steel used for gauge-making and other precision work; but ordinary mild-steel will do if it is case-hardened. It isn't worth while setting up an elaborate arrangement to machine out the slots, as you can do them by hand in far less time than it would take for setting-up alone. For beginners' benefit I will repeat that the best way of doing the job is to *cut the slot first*, and then file the outline around the slot. If you spoil a slot in a bit of metal, well that's all that there is spoiled; but if you spoil the slot in a link blank carefully filed to correct outline—'nuff sed!

To build the barrel around the bung-hole, in a manner of speaking, cut two bits of $\frac{3}{16}$-in. plate a little larger than the overall size of the links. Mark out to dimensions given in the illustration, then drill a few 7/32 in. or No. 3 holes down the centre of the slot. Run them into one with a rat-tail file, then carefully file away the rough edges, until a piece of $\frac{1}{4}$-in. silver-steel will run easily up and down the full length of the slot without being tight anywhere, at the same time not being slack enough to move from side to side.

Set out and drill the holes for the pins exactly on the centre-line of the slot (*very* important that) using No. 23 drill and 5/32-in. reamer. The holes must also be dead square with the links; so use either lathe or drilling-machine. Finally, file to given outline. If the ground cast steel has been used, harden and temper to a dark yellow. Heat to medium red, quench out in clean cold water, rub one side of the link on a bit of emery-cloth to brighten it, then lay it on a bit of sheet iron and hold it over a gas burner; the smallest burner on the kitchen gas stove will do fine. As soon as the brightened side turns to dark yellow, tip the link in the water again. Links treated thus will last indefinitely.

Inspector Meticulous will probably be looking for the lifting-block; well, there isn't one. On big sister the links are lifted by a lifting-link connected to the upper eccentric-fork pin, operated from the underneath weighbar-shaft. I've just turned this arrangement upside down, and on the little engine we lift the links by the lower eccentric-fork pin, connected to the over-head weighbar-shaft by a similar type of lifting-link.

The die-blocks are filed up from pieces of the same kind of steel as used for the links, a simple job requiring no detailed instructions. They should slide the full length of the slots without shake. Drill and ream a 5/32 in. hole through the middle of each, and counterbore to a depth of $\frac{1}{16}$ in. with a $\frac{7}{16}$-in. pin-drill, to accommodate the head of the pin which prevents the block coming off. Harden as above. A plain washer $\frac{5}{16}$ in. diameter, $\frac{1}{16}$ in. thick, with a No. 21 hole in it, goes between the die-block and the rocking lever, to act as a distance piece, and keep the link far enough away from the lever, to prevent the eccentric-rod forks hitting it as the link swings. The washers can be made from slices parted-off a bit of $\frac{5}{16}$-in. round silver-steel—centre and drill before parting-off—and hardened as above; or they may be left dead hard.

The pins are another "kiddy's practice job" (we used to reckon that "kiddies" included apprentices!) and are turned from $\frac{1}{4}$-in. round silver-steel. Watch two points; first, have the working surfaces perfectly smooth, no tool marks showing. Secondly, have the plain part of such a length that when the die-block and washer are mounted on the pin, and the latter pushed through the hole in the bottom of the rocking lever and nutted up perfectly tight, the die-block is free to turn on the pin; a nice little test of careful turning and fitting.

If the above parts are made of mild-steel, they must be case-hardened. Beginners note—heat them to bright red, and roll them in some good case-hardening powder, such as "Kasenit," "Pearlite" or any similar good brand. See that they are well covered, slots and eyes filled up; then reheat to bright red, and wait until the yellow dies out of the flame. Plunge into clean cold water, and carefully clean off all traces of the hardening powder. If the job has been properly done, a file should not be able to touch them, and your valve-gear will last indefinitely without appreciable wear.

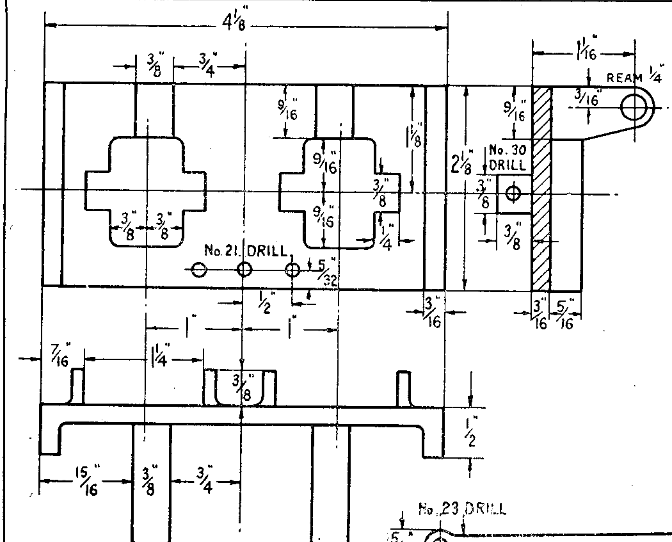
Rocking Levers

Unlike those on the big engines, the rocking levers are centrally pivoted; the full-sized ones had the upper half longer, giving a greater-than-normal valve travel without using larger eccentrics, and lengthening the throw of same. As our big slide valves want proportionately more "Sunny Jim" to drive them, than the piston valves of big sister, I adopted longer-throw eccentrics and equal-armed rocking levers. The latter are filed up from $\frac{3}{16}$-in. by $\frac{1}{2}$-in. mild-steel bar, to the given dimensions, and drilled and tapped as shown, taking the same strict caution as before, to ensure the holes going through

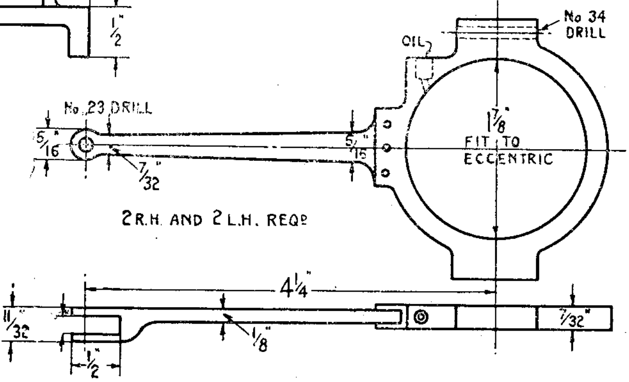
perfectly square. In order to get a good bearing surface, the fulcrum-pins are screwed hard into the levers, and take their bearing in the full $\frac{3}{8}$-in. width of the cast-on rocker brackets on the motion-plate; so they should run "till the cows come home" before any slackness develops. Both fulcrum-pins and valve-rod pins are simple turning jobs, made from hexagon steel, $\frac{3}{8}$-in. and $\frac{5}{16}$-in. respectively, held in the three-jaw.

$\frac{5}{8}$ in. from the cross-hole. Centre, drill $\frac{5}{16}$ in. deep with 5/32-in. drill, and tap $\frac{3}{16}$ in. by 40. Turn down $\frac{1}{4}$ in. of the end to a bare $\frac{3}{8}$ in. diameter for the sake of appearance; just take the corners off the square. Round off the end of the fork, same as you did the eccentric forks, and poke a 5/32-in. parallel reamer through the cross-hole.

The valve-rods are filed up from $\frac{1}{8}$ in. by $\frac{5}{16}$ in.



Left—Motion plate for "Maid of Kent"



Right—Eccentric strap and rod

Note that the plain part of both pins, is made long enough to accommodate a $\frac{1}{16}$-in. rubbing washer between the head of the pin and the bracket, in one case, and the valve-rod in the other; see plan and cross-section views of the complete layout. Note—beginners especially—the threads should be a tight fit in the tapped holes in the rockers; if these merchants came out when the engine was doing the knots, things would happen, and mighty quick at that!

Valve Crosshead and Rod

The valve crossheads are made from a bit of $\frac{3}{8}$-in. square mild-steel. Beginners should get a bit about $2\frac{1}{2}$ in. long, drill a No. 23 hole across each end, about $\frac{3}{16}$ in. from the end, then slot the ends by clamping the piece under the slide-rest tool-holder and running up to a $\frac{1}{8}$-in. slotting cutter on a stub mandrel in the three-jaw. Saw off each end to about 1 in. length, chuck truly in the four-jaw, and face the sawn end to exactly

steel, and I need add nothing to that, except to remind beginners that the dimension given, viz. $4\frac{3}{16}$ in. between centres of holes, applies after the rods have been set over as shown in the plan view. The eyes should be case-hardened by the process already mentioned.

The weighbar-shaft itself is a piece of $\frac{5}{16}$-in. round steel rod squared off each end in the lathe, to a length of $4\frac{1}{8}$ in. It carries two lifting-arms and a reversing-arm. The former are cut from $\frac{1}{2}$-in. by $\frac{1}{8}$-in. steel, and constitute merely a plain filing and drilling job, the sizes being given in the illustration. Drill the smaller ends No. 23, and have the larger ends a tight fit on the shaft, drilling a little undersize, say 19/64 in. or letter N drill, and easing out with the "lead" end of a parallel reamer until they will just go on tightly. Then drive on to the position shown. To ensure the small ends lining up, test by putting the No. 23 drill through both at once; it should slide freely.

Negative Lead

by J. N. Maskelyne, A.I.Loco.E.

THE fact that certain references to negative lead have appeared recently in THE MODEL ENGINEER, has brought in a number of letters, some of which run to great length; but our space is still so limited, and our correspondents have so much to write about this interesting subject, that we have been confronted with quite a problem in deciding what to do about it. Perhaps, a general summing-up will meet the situation and satisfy our correspondents, some of whom, however, have obviously confused "lead" with "pre-admission."

First, let us be perfectly clear as to what "lead" is. It is the amount by which a valve has opened a port to steam when the main crank is on dead-centre; the term, as applied to a steam engine cylinder, has no other meaning. But this definition is descriptive of *Positive* lead, i.e., an actual opening of the steam port. *Negative* lead can be best defined as the distance which a valve must travel before it can begin to open the steam-port, when the main crank is on dead-centre.

In full-size practice, negative lead is not very often met with, and then only in certain conditions; G. J. Churchward's two (outside)-cylinder 4-6-0 and 2-6-0 tender engines and the larger 2-6-2 passenger tank engines for the Great Western Railway appear to have been the first to have negative lead consistently, and in them, as in all the subsequent engines of the same types, the negative lead was more incidental than deliberate. No locomotive valve-gear has ever been designed to give negative lead as an *essential* feature; wherever negative lead has been found, its presence has always been due to the fact that the gear has been so designed that a definite, predetermined amount of *positive* lead shall be available when the gear is notched up to its running position. This *is* essential and of the utmost importance in steam locomotive design.

The effect of negative lead depends chiefly upon the design of the cylinders, steam-chests and valves; but the type of valve-gear also has some influence. Probably, no locomotive fitted with a radial gear like Walschaerts, Baker or Southern, and incorporating a negative lead, has ever been built; or, if it has, it could never have done any fast running, or moved a heavy load! The lead on a radial gear is constant, whatever the point of cut-off, unless some special device is added in order to provide a variable lead.

A link-motion, however, gives a variable lead automatically as the gear is notched up; and, in locomotive practice, this is a valuable feature. The Stephenson valve-gear is, perhaps, the best-known of all link-motions, and the only one now found extensively used in steam locomotives. It can be easily arranged so that the amount of lead increases as the gear is notched up. There is a risk, however, that, when the gear *is* notched up, the amount of lead may be too much to give satisfactory working of the engine. This state of affairs is likely to occur when, for structural reasons, the eccentric-rods have to be short; and the reason for this is simply that the increase of lead is greater than when the eccentric-rods are long. This is one of the inherent characteristics of the gear, and cannot be avoided.

G. J. Churchward, was, so far as is known, the first engineer to turn what looks like a decided weakness into something worth having. For the engines already mentioned, Churchward designed cylinders which incorporated piston-valves in adequate steam-chests, large ports, very short passages from ports to the cylinder-bores and a very long stroke for the pistons. He has stated definitely that he spent twenty years in studying valve-gears; so that it is more than likely that he had decided upon the general features of the cylinders, just mentioned, having clearly in mind the arrangement of valve-gear he would adopt. For, at the time, he was planning a system of standardisation which, almost immediately, was adopted and has since plainly and successfully influenced Swindon locomotive practice.

Now, on the express passenger and tank engines mentioned, the Churchward arrangement of Stephenson link-motion is set to give about $\frac{1}{8}$-in. lead when the gear is notched up to about 25 per cent. cut-off; the fact that this gives a negative lead of nearly $\frac{3}{16}$ in., in full gear, did not deter Mr. Churchward, but he was not concerned with it as an *essential* feature of the gear.

The effect of the negative lead is probably negligible; at least, it has never had any bad effect upon the performance of the engines that have it, for it is plain for anyone to see that they are foremost among the liveliest engines, which have ever been designed on the two-cylinder principle. It was a Churchward "Saint"-class 4-6-0, No. 2928, *Saint Sebastian*, which was responsible for the most vigorous start that I have ever known out of Paddington station, or, for that matter, out of any other station; and this as recently as March, 1947. I published a short description of this particular effort soon after it occurred (see THE MODEL ENGINEER, April 17th, 1947, page 485).

In full-size engines with cylinders designed on the plan referred to above, negative lead is no detriment; in miniature locomotives of all types, it probably has no effect whatever, if the steam passages are short and the ports large. At its worst it can never have so retarding an effect at starting as too much positive lead; the latter, in an engine with two big cylinders designed in the Churchward manner, may well have the effect of stalling the engine in full gear, simply because high-pressure steam can have access to the same side of both pistons at once if the engine happens to be standing on dead centre when the regulator is opened.

*Making Scale Ships' Fittings

Suitable for motor-yachts, cabin-cruisers, A.S.R.Ls., M.T.Bs. and other "light craft"

by W. J. Hughes

THE Browning guns on the prototype are mounted in Avro turrets, and are mounted, together with the gunner's saddle and backrest, on a complicated system of links, to allow for the saddle and backrest to rise and tilt forwards as the guns depress, and to depress and tilt backwards as the guns are elevated, so that the gunner will be in the correct position appropriate to his sights.

It was very tempting to think how nice all these things would look if properly made to work, and for a long time (as I worked on the other bits and pieces) I toyed with the idea, but when I sat down and drew the thing out to ½ in. scale, I came to my senses! I draw the line at "watchmaking"—and in any case, the "works" would be largely hidden inside the turrets.

It was, therefore, decided to make, and sweat up solid, an assembly which would look realistic enough, and yet stand a bit of a knock if need be. Fig. 31 gives a general idea of the assembly.

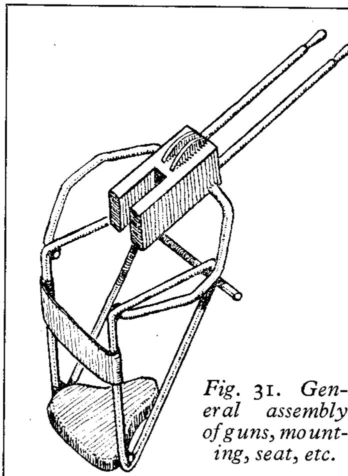


Fig. 31. *General assembly of guns, mounting, seat, etc.*

Each barrel was turned from 18-gauge nickel wire in the chuck. The end having been centred with my smallest Slocombe drill, it was drilled down about 3/16 in. deep with a No. 65 drill, the hole being opened out with a triangular scraper to give almost a feather edge, after which the outside of the flame-damping cone was turned to shape.

Each pair of breech-blocks was filed in one piece from a stub of 5/16-in. sq. brass rod, drilled at the end for the barrels, and a small vee-notch filed across the underside to rest on the mounting. The latter having been bent up from 16-gauge brass wire, barrels, blocks and mountings were silver-soldered together.

Gunners' seats were filed bicycle-saddle shape from ½ in. × ⅛ in. brass bar, and side frames and saddle-bearers were bent from 18-gauge wire. The side frames were joined by a strip of 30-gauge brass to represent the back-rest, and having placed the saddle-bearer in position, this sub-assembly was silver-soldered.

After cleaning up, the gun-mounting was sweated to the saddle-mounting, and the latter was sweated to the stepped brass ring which forms the bottom of the dome and fits into the top of the barbette (Fig. 32). The ring had been turned previously from thick-walled brass tube.

Two coats of grey cellulose, with black flame-cones, saddle, and back-rest, completed this part.

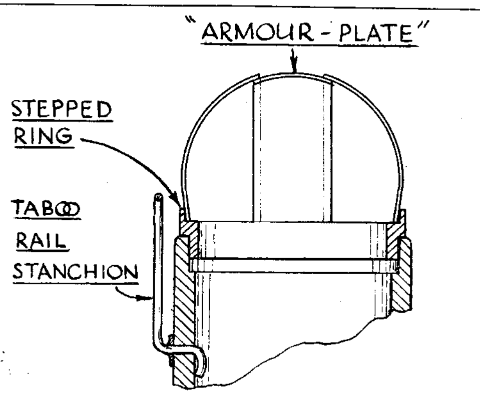


Fig. 32. *Details of turret—guns omitted for clearness*

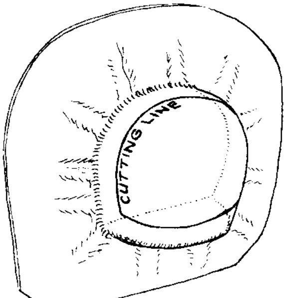


Fig. 33. *Celluloid blank after forming for half-dome*

A Word of Warning!

Gun-turrets and guns are among the most prominent features of any A.S.R.L., and it will pay a handsome dividend in the finished appearance of the boat if reasonable care is taken with them. In this, as in all boat fittings, the *scale* must be borne in mind all along, even if one hasn't a scale drawing of the part in question. For example, these Browning guns

Continued from page 508, "M.E.," May 13, 1948.

are 0.303 in. calibre—then the external diameter of the barrels cannot be more than 1 in., can it? But in ½ in. scale, or 1/24th full size, 1 in. is represented by 0.040 in., or 19-gauge wire. So actually, the 18 gauge (0.048 in.) I used is *oversize* for these barrels!

"Pooh!" you say, "child's play!" Perhaps, but I have seen an alleged ½-in. scale A.S.R.L. which had gun-barrels 3/16 in. diameter—Browning guns 4½ in. diameter—bigger than the barrels of Oerlikon guns! Which reminds me that on some of the later A.S.R.L.'s a single-mounted Oerlikon was fitted in place of the aft twin-Browning turret.

On this particular model, too, the "domes" were simply hemispheres, with no attempt to reproduce their correct sectional appearance, and no gun-mountings of any kind. And the "searchlight" was as big as a dustbin!

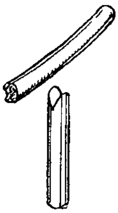


Fig. 34. *Taboo-rail upright vee-notched to receive rail*

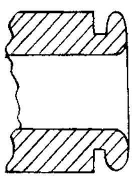
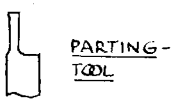


Fig. 35. *Forming the life-buoys*



This matter of scale size, of course, applies to *all* fittings of *all* ship models—a worthier than I, one "Jason," keeps bringing up the subject in his articles. If in doubt, use common-sense, and if *still* in doubt, then leave it off until you find out!

Turret Domes

This type of turret has an orifice in the dome to allow for the elevation and depression of the guns, the orifice being capable of being closed (when the guns are withdrawn) by means of overlapping sliding shutters. At the back, as a sort of continuation of the orifice, is a curved piece of armour-plate to cover the gunner's back (Fig. 32).

The two halves of each dome were moulded from celluloid using the jig and die, shown in Photo 3. The male die was turned to shape from a scrap of mahogany, and was planed flat on one side to receive the handle, which is a piece of dowel rod. The flat also acts as a reference face when pressing the moulding to shape. The female die is made from odds and ends of wood; the baseboard is "battened" at the ends to prevent it warping in the steam, and has a hole chopped in it to be well clear of the die. Over the hole is screwed a piece of ⅜-in. plywood, which has the female die proper cut in it—a hole which clears the male die by about 3/64 in. all round. The sharp edges of the hole were rounded off and glasspapered to allow the celluloid to flow easily without being cut. The third layer (in the photo), is another piece of wood with a similar but somewhat larger hole; it is pivoted on a wood-screw (near vent. in the picture), so that it could be swung round into position and fixed quickly with another screw on the opposite side.

The method was to heat the dies and a piece of celluloid thoroughly over steam from a saucepan. The celluloid having been placed over the female die, the top piece was swung round and the second screw inserted—the screws must not be too tight or the celluloid will not flow. Resting the board once more on top of the saucepan (after the latter had been removed from the gas-ring) so that the celluloid and dies did not cool off, the hand-die was pressed home steadily until the moulding was sufficiently deep; then, still holding the hand-die in place, the whole lot was lifted and quenched under the cold-water tap.

When the moulding was removed, it was similar in shape to Fig. 33. Note that ample depth was allowed, so that when the required piece was cut away (shown by the line marked "Cutting Line"), it was true to the shape of the male die, with no wrinkles.

It was found also that the celluloid had a definite "grain," and that it flowed more easily when the grain ran from top to bottom, than from side to side. The pieces of celluloid were trimmed to the shape shown in Fig. 33 before moulding, as it tended to wrinkle less.

Altogether some twelve mouldings were made, plus three or four which split for various reasons while moulding. Four were required for the turret-halves, four more to cut up for "armour-plate" and "shutters," and four more "just in case."

The halves of the domes were cut out from the mouldings with a sharp knife, the half being supported by the male die while cutting was in progress. Some brisk polishing with metal polish was necessary to remove the "grain," and then the halves were cemented into the stepped rings. Pieces were cut to represent the rear armour-plate and the parts of the sliding shutters, and were cemented into position, securely holding the two halves together and giving a surprisingly rigid structure.

Narrow strips of thin aluminium foil having been cut, these were cemented to the domes to represent the metal framing of the domes, and then the front panels of "armour-plate" were cut and fitted at either side of the orifice. The framing, armour-plate, and stepped ring were finished with two coats of black cellulose.

One of the completed domes is seen in Photo 3; the gunner's saddle with its supports can just be seen behind one of the unused vent. cowls, and below the stepped ring.

Barbettes (Photos No. 3 and 4)

The barbettes are turned from thick-walled plastic tube, which is very strong but much lighter in weight than brass. As shown in Fig. 32, the top of the barbette is counter-bored to take the spigot of the stepped ring of the dome. Holes are drilled and tapped 10-B.A. up into the walls of the barbettes, to take four screws which pass up through the decks to secure the barbettes.

The aft barbette is only ⅝ in. tall, and a hole had been cut previously in the deck so that the

gunner's seat could project into the cabin below, as it must have done in the prototype.

Taboo-Rails (Photos No. 3 and 4)

The taboo-rail of the bridge turret is fixed to four uprights, which in the prototype are bent at right angles, and have feet which are bolted to the barbette itself. For the dwarf aft turret, the uprights are not bent, and their flanges are bolted direct to the deck itself.

For the model, four pieces of 18-gauge brass wire were pushed into holes drilled in a piece of wood, at the corners of a pencilled square. The top end of each wire had been filed at an angle, and a vee-groove filed across it, so that the rail itself could rest therein (Fig. 34).

Using a piece of $1\frac{3}{8}$-in. diameter tube as a former, the 18-gauge rail was bent approximately to shape, and tried in position, when a little extra manipulation with the fingers gave the correct shape. The ends of the wire rail were now butt-jointed with "Easyflo," and the rail having been placed in the vee-grooves on the uprights, these four joints were silver-soldered. After cleaning up, the assembly was removed from the jig, and a small washer, previously turned from brass rod, was sweated on each "leg," to represent the flange, leaving a short length of the leg protruding.

With the aft turret, these protruding lengths were forced into holes drilled direct in the deck, but in the bridge or forward turret, the uprights were bent at right-angles just above the flange, and the ends inserted into holes drilled in the barbette. This needed a bit of "wangling," and distorted the rail slightly, but a little further manipulation rectified the damage, and the ends were pressed down inside the barbette to secure the taboo-rail in position (Fig. 32).

Lifebuoys (Photos No. 4 and 5)

A piece of $1\frac{1}{4}$-in. diameter plastic rod was bored out, turned to the section shown (Fig. 35), and parted right off. Two such rings having been made, each was placed in turn in the chuck so that the other inside corner, left square from the parting-off, could be rounded off.

The next stage was to wrap each buoy with a cemented strip of very fine cambric, catching in the linen-thread life-line in four places as wrapping proceeded. After painting with white dope, the legend "R.A.F. 144" was painted in black with a fine brush.

Aerials (Photos No. 4 and 5)

To make the spreader rings of the aerials, a piece of dark brown plastic rod $\frac{5}{8}$ in. diameter was chucked, and skimmed up true. Having drilled out the interior with a $\frac{3}{8}$-in. diameter drill, the rings were parted off 1/32 in. thick.

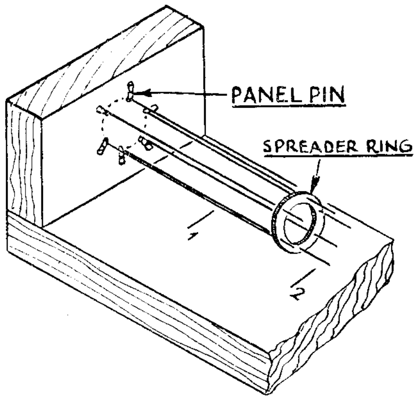


Fig. 37. Jig for building-up aerials

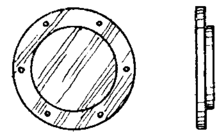


Fig. 36. Jig for drilling aerial spreader-rings

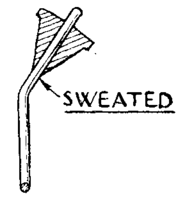


Fig. 39. Dummy voice-pipe

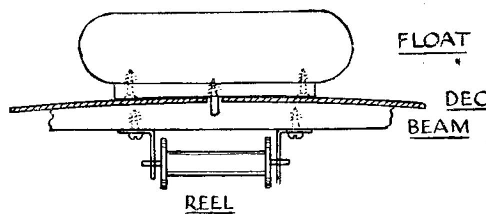


Fig. 38. Arrangement of Carley Float to act as tell-tale in case boat sinks. Thread omitted for clearness

In order to get the six holes in each evenly spaced, a small brass jig was turned from a stub of $\frac{5}{8}$-in. diameter brass rod, having a spigot on which the rings would fit, and with six equidistant No. 70 holes drilled near the circumference (Fig. 36).

The method was to place a ring on the spigot (which must not protrude beyond the ring), place in the bench-vice, drill three of the holes (the others being covered by the vice jaws); then turn it round and drill the other holes.

Another jig was made for making up the "sausage" aerials themselves, consisting of a length of wood with two uprights (Fig. 37 shows one end of the jig). The base was marked off at distances corresponding to those between the spreader rings, but note that the distance 1-2 is that between the first ring and the *beginning* of the sausage—i.e., the *first* ring comes at station 2. Six panel-pins were driven into each upright, and bent over, as shown.

The aerial "wires" were made from nylon fishing-line, of a green colour approximating to the verdigris on copper aerials. One length having been knotted to the top pin, five spreader rings were threaded on, and the other end of the length was tied off to the top pin on the other upright. The second length to be threaded was the bottom one, and when this had been tied off it was easy to thread the other four.

After spacing the rings at their respective stations, they were fixed to the "wires" by tiny dabs of Durofix; then a loop of the thread was passed right round the wires at station 1, cemented, tightened up, and knotted. The other end of the "sausage" was secured similarly.

The insulators fore and aft are short lengths of a white plastic knitting-needle—they can be seen on Photo 2.

Voice Pipe and Switches (Photo No. 5)

A small cone was turned from brass rod, drilled, and sweated to a length of 18-gauge brass wire (Fig. 39). After bending the wire to shape, the other end was bent at right-angles and pushed into a hole drilled just below the facia-board at the port side. The "pipe" is further secured by two staples bent up from beheaded and shortened pins.

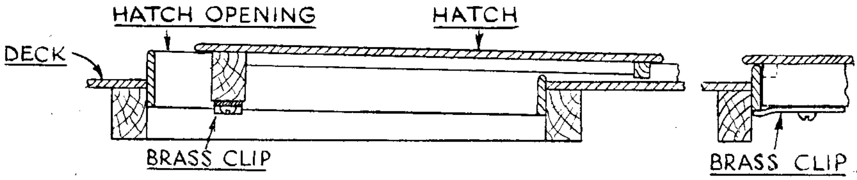


Fig. 40. Details of sliding-hatch

Handrail Knobs (Photos No. 4 and 5)

An old dodge was used in making the handrail knobs—they are simply small split-pins pushed through small washers, and sweated to the latter and to the handrails. Those on the bridge are pushed through holes drilled in the bridge sides, and have further washers sweated inside to secure them—one of these may be seen on Photo 5, over the top of the Carley float. Those on the aft-cabin roof, which do not show on any photo, are similar, but the ends are pressed into holes drilled through the roof into the roof-framing.

Carley Float (Photos No. 4 and 5)

Shaped from solid balsa, the model Carley float is designed to act as a "tell-tale" in the event of the boat sinking. The net which closes the "bottom" of the float is woven from strong linen thread, and floor-slats of $\frac{1}{16}$-in. sq. balsa are stained to represent teak, and cemented to the net. Lifelines are of the same thread, and two small paddles were carved from strip-wood.

The float fits on two chocks on the aft cabin-roof, but in the model these chocks are secured to the *float*, not to the roof. Screwed centrally into each chock is a brass screw, of which the shank protrudes and the head has been cut off.

These headless screws fit loosely into holes drilled in the deck, and so keep the float in position; at the same time the fit is sufficiently loose to allow the float to come away should the boat sink. Attached to the underside of the float is a length of linen thread, which passes through a hole in the deck and is wound round a reel (turned from aluminium rod) which can revolve freely on a spindle mounted on angle brackets, the latter being screwed to a deck beam. Fig. 38 shows the arrangement.

In theory, then, if the boat sinks (despite her seven watertight compartments), the float will remain at the surface, the line will unreel as the boat goes to Davy Jones, and it should not be difficult to cheat the latter of his prey. No suggestion is made, of course, that the boat could be salvaged with the linen line!

I should have mentioned that the cabin roof, though detachable, fits tightly enough to ensure that it too will not float away from the boat.

The "switches" on the dash-board are short lengths of 18-gauge wire pushed through thrust washers (as used by aeromodellers). After sweating the joint, the lower end of the wire was pushed into a hole in the dash-board.

Sliding Hatch

When I described the A.S.R.L. itself in THE MODEL ENGINEER for August 14th, 1947, I mentioned that I.C. propulsion was first considered, and that the hatch was made to slide so that the exhaust could be led to this aperture. With the present electric drive, the motor-switch is placed under the hatch. It is of the "button" (reading-lamp) type, where the button is pressed down to switch on, and then down again to switch off.

The sketch (Fig. 40) shows how the hatch opening is framed underneath with $\frac{1}{4}$ in. $\times$ $\frac{3}{8}$ in. section deal, and to this is cemented a coaming of $\frac{3}{8}$ in. $\times$ $\frac{1}{16}$ in. birch—the long sides are extended to form slides for the hatch-cover. The latter is a rectangle of $\frac{1}{16}$ in. ply, which has cemented at its forward end a length of 5/16 in. $\times$ $\frac{1}{4}$ in. section deal, and down each side and at the back 3/32 in. sq. section balsa.

A strip of thin gauge brass is screwed to the 5/16 in. $\times$ $\frac{1}{4}$ in. (front) strip, its ends protruding so as to slide under the bottom edge of the coaming, so that it retains the hatch in position, yet allows it to be slid open or shut.

When the boat is being run, the hatch is kept open about an inch, so that one finger can be put through to switch on and off easily.

Conclusion

And with that I close this short series of articles, hoping that they have been of some small value, and perhaps of instruction, to my readers. Some of the methods described are old favourites among power-boat men: some are original—though since as the adage says, "Great minds think alike," it is highly probable that somewhere some reader or readers will have already "originated" my "original" ideas. Such is life!

Be that as it may, what *really* matters is the final result. And if your fittings *look* right, by whatever method they are made, then good luck to you for keeping the flag of realism flying!

IN THE WORKSHOP

by "Duplex"

11—TAPER PINS

TAPER pins are used largely for securing collars, small pinions and other such components to shafts; when so employed they have the advantages that they give a secure fixing, and can at any time be withdrawn when dissembly of the parts becomes necessary.

Moreover, a well-fitting taper pin is not liable to work loose, and, in the event of damage, the pin is readily renewed and the bore re-reamed. The use of taper pins as register pegs was described in a previous article, and, here again, wear can easily be made good by a reaming operation to allow the pins to protrude further.

Before describing the methods employed in fitting taper pins, it will be as well to consider the form of the pins and the dimensions of the reamers used for this operation.

Standard taper pins of good quality are accurately machined to a taper of $\frac{1}{4}$ in. to the foot and are designated either by their diameter, measured at the large end and expressed as a fraction of an inch, or by an arbitrary number, ranging from 000000, or 6/0, to 12, in accordance with the Morse taper pin scale.

If there is any doubt as to the accuracy of a taper pin, this can be checked by making two scratch marks on the pin exactly 1 in. apart; the diameter of the pin at both marks is then measured with a micrometer, and if the taper is correct, that is to say $\frac{1}{4}$ in. to the foot, the difference of the two diameters will be 0.0208 in. The regularity of the taper can be checked by making a further scratch mark exactly mid-way between the two previous marks and measuring the diameter of the pin at this point; this dimension should, of course, be equal to the mean of the two former diameters.

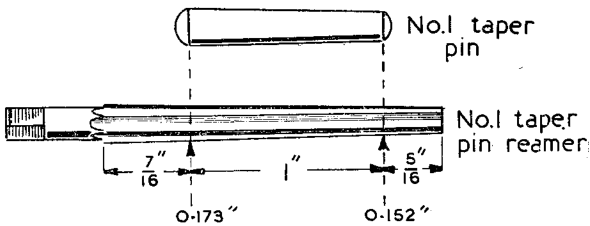


Fig. 1

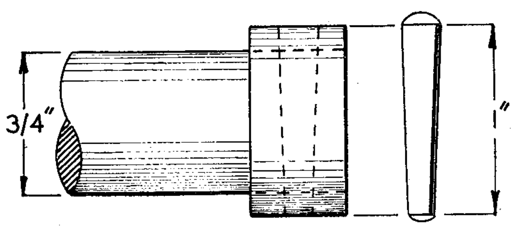


Fig. 2

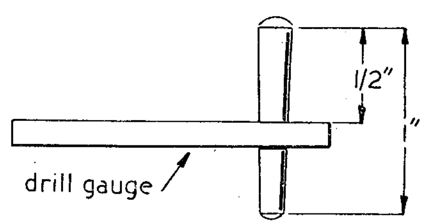


Fig. 3

An alternative method of estimating the taper is to insert the pin in the number size drill gauge, as in Figs. 3 and 4, and to mark its depth of entry in either case; the distance between the two marks is also measured. The smaller diameter, as determined by the drill gauge, is then subtracted from the larger and the difference is divided by the distance apart of the two marks.

As an example, when a No. 2 taper pin was fitted into the No. 10 and No. 18 holes in the gauge the marks were found to be 55/64 in. apart. Now, the diameter of the No. 10 hole is 0.1935 in. and of the No. 18 hole 0.1695 in. The difference, 0.024, when divided by 55/64 equals 0.0206, which is sufficiently close to the nominal value of 0.0208 to show that the pin has the correct taper.

As will be apparent in the drawings in the text, both ends of the pin are deeply chamfered, so that any bruising caused when driving the pin with a hammer will not interfere with its fitting. If, therefore, a pin is cut short, the cut end must again be chamfered or well-rounded before the pin is inserted.

Reamers

For each size of taper pin a corresponding reamer is used to form the correct taper in the previously drilled hole. A list of the smaller reamers in both the fractional inch and the number sizes is given in the two following tables: and the relationship between a No. 1 taper pin and the corresponding reamer is shown in Fig. 1.

As these small fluted reamers are very accurately made with ground cutting edges, they are rather expensive, but with careful use they should have a long life.

Fitting Taper Pins

As a practical example of fitting a taper pin, let us suppose that a No. 1 taper pin 1 in. in length is to be used to secure a collar 1 in. in diameter on a shaft of $\frac{3}{4}$ in. diameter, as represented in Fig. 2.

Reference to Fig. 1 will show that the small end of the pin is 0.152 in. in diameter, corresponding to a No. 24 drill; also, this is the diameter of the reamer $\frac{5}{16}$ in. from its tip.

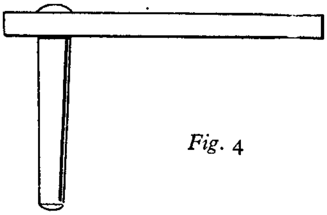


Fig. 4

The first step then is to drill a hole with a No. 24 drill across the diameter when the collar has

FRACTIONAL SIZES

Nominal diam.	Diam. small end	Diam. large end
in.	in.	in.
$\frac{1}{16}$	0.044	0.065
5/64	0.060	0.081
3/32	0.070	0.096
7/64	0.081	0.122
$\frac{1}{8}$	0.092	0.128
5/32	0.117	0.159
$\frac{3}{16}$	0.138	0.190

NUMBER SIZES

Nominal diam.	Diam. small end	Diam. large end
No.	in.	in.
000000	0.0606	0.0814
00000	0.075	0.0984
0000	0.088	0.114
000	0.101	0.1322
00	0.112	0.151
0	0.1245	0.166
1	0.135	0.182
2	0.151	0.203

been mounted in place on the shaft; is a smaller drill is used, more metal will have to be reamed away to allow the pin to enter for the correct distance. When the hole has been drilled and cleared of chips, the reamer is secured in a small tap wrench, and after it has been lubricated with lard oil in the case of steel, it is inserted in the hole. Only light cutting pressure should be applied to the reamer while it is carefully turned in a clockwise direction, and at frequent intervals it must be withdrawn to clear the chips from the flutes and re-lubricate the cutting edges. If the reamer is forced in any way, the fully-hardened slender cutting edges may be broken.

On no account should the reamer be backed out of the hole by turning it in the reverse direction, as this will in time blunt the cutting edges and may even cause them to become chipped.

Do not try to hurry the work, and at the first feeling of stiffness in turning, withdraw the reamer and oil it after clearing the flutes.

Continue the reaming until, in this case, the tip of the reamer protrudes $\frac{1}{4}$ in. through the hole; this will allow for an interference fit of a little more than a thousandth of an inch when the pin is driven home. If, on the other hand, the work were continued until the tip of the reamer was $\frac{5}{16}$ in. clear of the hole, as shown in Fig. 1, the pin could then be pushed into place with the fingers and would protrude too far when properly seated. The same procedure is used when fitting pins of other sizes and of different lengths.

Supposing, for example, that only the upper $\frac{1}{2}$ in. of a 1-in. pin is to be used, then the easiest method of determining the size of drill to employ is to try the small end of the pin in the drill gauge, as shown in Fig. 3. The drill gauge is again used to find the diameter of the head of the pin, as in Fig. 4.

The reamer is then carefully inserted in this hole and is marked, as indicated in Fig. 5, with a grease pencil to show the depth of entry required to seat the pin up to its head.

After the hole has been drilled in accordance with the size indicated in Fig. 3, the reaming operation is carried out and is continued until the reamer has entered for a distance a little short of the pencil mark. The pin is then tried in place and, if necessary, the reamer is again used so that only a small amount of draw remains for seating the pin firmly in place.

When fitting or withdrawing taper pins they should, whenever possible, be pressed into or out of place in the vice or by means of a clamp; as an alternative, a hammer and a brass punch may be used in awkward places.

The writers remember seeing, many years ago, an Army Ordnance artificer who had the un-

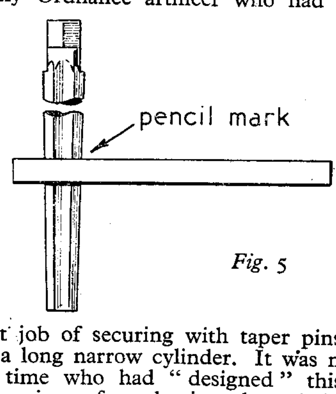


Fig. 5

pleasant job of securing with taper pins a ring within a long narrow cylinder. It was not clear at the time who had "designed" this extraordinary piece of mechanism, but obviously no one who foresaw any possibility of his having to assemble it personally. The upshot of the matter was that the artificer, being a skilled and patient craftsman, had gone to the trouble of making a small hydraulic jack, with the aid of which he was able to press the pins into place when working in a space so confined that no hammer could be used.

When fitting taper pins, particularly the larger sizes, a method of step-drilling is often employed to lessen the work of reaming. As illustrated in Fig. 1, the large end of the No. 1 pin is 0.173 in. and the small end 0.152 in.; the mean diameter at the mid-point is, therefore, 0.1625 in.

To step-drill the hole, as shown in Fig. 6, a No. 24 drill is, as before, passed right through the work, and this is followed by a No. 20 drill, of 0.161 in. diameter, fed in for half the total depth. When even larger tapers have to be reamed or machined, this form of preliminary drilling can be carried out in any number of steps, depending on the size and depth of the hole.

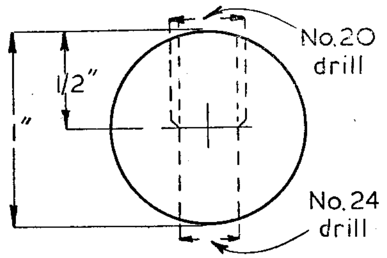


Fig. 6

The size of the pin used in any particular piece of work depends, in part, on the diameter of the shaft, for if too large a pin is fitted, the shaft will be weakened, but, on the other hand, the pin should be of a size to provide sufficient bearing in the collar or pinion to withstand any working strain imposed.

Manifestly, when the taper pin is used for light duty only, the appearance of the work will be improved by fitting a pin of small diameter.

It is usual, particularly in instrument and model work, to give a good finish to the ends of taper pins. For this purpose, the pin should be gripped, first by one end and then by the other, in the chuck of a high-speed drilling machine.

A fine file is then used with light strokes to round the ends of the pin; this is followed by holding a strip of fine abrasive cloth against the file and continuing the filing strokes.

To polish the rounded ends of the pin, the emery cloth is placed on a piece of soft wood on the drilling-machine table and the revolving pin is fed against it, but the cloth should be moved frequently to prevent the work becoming ringed.

As a final measure, the cloth may be pressed against the pin with the tip of the finger.

If desired, the ends of the pin can be burnished by following the emery cloth with a piece of polished hardened steel; this tool, when held in the hand, is applied with a rocking motion to conform with the curvature of the end of the pin.

While on the subject of finishing components, it may be opportune here to point out that there should be an equality of finish throughout any particular piece of work, whether it be a simple tool or a model for exhibition. It is not good practice to leave some parts roughly filed or showing turning marks, whilst others are highly polished, but, on the other hand, if all the components are finished by, say, a turning operation, then the work is more likely to have a correct and pleasing appearance.

Taper Broaches

As has already been stated, fluted taper pin reamers are expensive, and for this reason, perhaps, taper broaches, costing much less, are sometimes used in their place.

These broaches, which appear to be ground free-hand, can be obtained in graduated sets covering a range of from 1/32 in. to $\frac{3}{16}$ in., but before they are used for fitting taper pins it is as well to check their accuracy. This is done, as in the case of taper pins, by inserting the broach in the drill gauge and noting the diameter at either end; the distance between these two points is measured and the taper in thousandths of an inch per inch is then readily calculated.

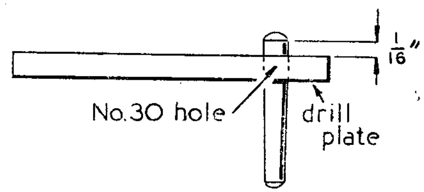


Fig. 7

Three of the larger members of a set of five-sided taper broaches were measured in this way, and it was found that the taper was 18, 14 and 13 thousandths per inch respectively, instead of the normal 20.8, thus showing that these particular broaches were quite unsuitable for reaming holes to receive standard taper pins.

Fitting Register Pegs

In a previous article reference was made to the fitting of taper pins to serve as register pegs for aligning machine components, in place of the more usual parallel pins; and, as a correspondent asks for further information on this point, it may be helpful to some less experienced readers if a

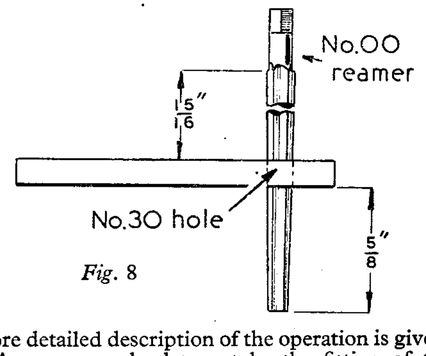


Fig. 8

more detailed description of the operation is given.

As an example, let us take the fitting of the keep plate of the lathe top slide, for when this plate is removed, in order, for example, to carry out shaping operations in the lathe, it is important that it should be capable of being readily replaced with the feed screw correctly aligned with its nut. In this instance, it is not uncommon to find that the securing screws allow considerable latitude of movement, which entails realigning the keep plate whenever it is replaced after removal.

To obviate this, register pegs should be fitted

to ensure the correct location of the keep plate, leaving the screws to be solely concerned, as they should be, with holding the parts together. The method of fitting parallel register pegs or dowels has already been described in detail and need not be referred to further.

The following actual example of locating the top slide keep plate may be cited to explain the method of using $\frac{1}{8}$-in. taper pins for this purpose.

After the holes had been cleared of chips by means of a pipe cleaner, it was found, as anticipated, that the short taper pins entered their holes as shown in Fig. 7, that is to say, they projected exactly $\frac{1}{16}$ in. The keep plate was then detached and the pins were pressed into it in the vice until the tapered portion was flush with the surface.

The next and final step was to open out the holes in the casting with the taper reamer until the keep plate could just bed again correctly in place.

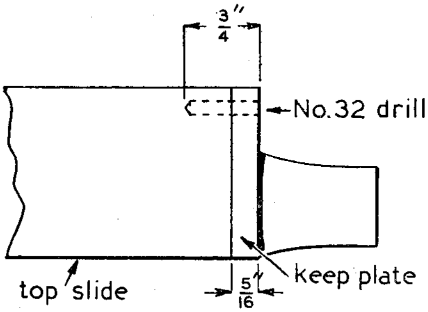


Fig. 9

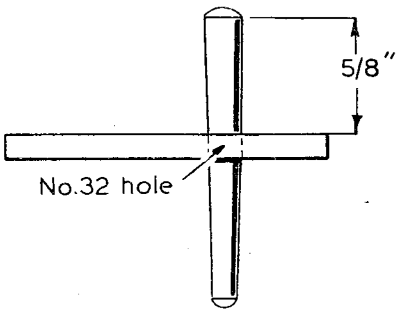


Fig. 10

A nominal $\frac{1}{8}$-in. standard taper pin $1\frac{1}{2}$ in. in length was found to mate with the No. 30 hole in the drill gauge, leaving $\frac{1}{16}$ in. of the upper end of the pin projecting, as shown in Fig. 7. A No. 00 standard taper pin reamer when inserted in the same hole is projected $\frac{5}{8}$ in. at its lower end and $\frac{15}{16}$ in. at its upper end, as seen in Fig. 8. As the thickness of the keep plate shown in Fig. 9 was $\frac{5}{16}$ in., and as it was decided that the pin should project into the top slide casting for $\frac{1}{4}$ in., this made the total length of the pins required $\frac{9}{16}$ in.

Two pins were, therefore, cut to this length and their ends rounded off. When inserted in the No. 32 hole in the drill gauge, a full-length pin projected $\frac{5}{8}$ in., as shown in Fig. 10; a No. 32 drill was, therefore, selected as the correct size for drilling the hole prior to reaming.

After the keep plate had been accurately aligned and secured in place with its fixing screws, the casting was bolted to an angle plate mounted on the drilling-machine table, and two well-spaced holes to receive the pins were drilled with the No. 32 drill to a depth of $\frac{3}{4}$ in., in order to give end clearance for the reamer. Then, with the keep plate still secured in place, the No. 00 reamer was carefully worked in by hand until, as shown in Fig. 8, it projected exactly $\frac{15}{16}$ in.

This method of fitting register pegs has the advantage that any looseness, which develops as the result of wear, can readily be taken up by reaming the holes in the keep plate so as to allow the pegs to project further; moreover, the keep plate is easily removed as, unlike parallel dowels, the tapered pegs do not tend to bind in their holes if the plate is tilted during dissembly.

When a new feed nut is fitted to the slide, it may be found that the keep plate requires some realignment, and when this is necessary it is inadvisable to attempt to correct the position of the register peg holes by means of a reamer alone, for this may well damage or even break a slender reamer.

It is preferable, therefore, to re-drill these holes as in the first instance and then to fit larger taper pins.

Finally, we would suggest that when buying taper pins, those of full length should be selected, for any cut-off pieces may come in useful at another time, and, moreover, as a $\frac{1}{8}$-in. taper pin $1\frac{1}{2}$ in. in length is little more than 3/32 in. in diameter at its small end, this enables the portion to be selected that is best suited to the work and, at the same time, matches the reamer available.

For the Bookshelf

Electrical Engineering: Scope, Training and Prospects. By Fredk. W. Purse. (London: Southern Editorial Syndicate Ltd.) Price 5s., postage 3d.

The writer of this book, who is well known as an electrical engineer, and a prominent figure in many industrial organisations and institutions, deals mainly with this subject from the aspect of its possibilities as a career. There is no doubt whatever that electricity is becoming more and more essential to industry and the community, and whatever may be uncertain about future national prospects, it is quite certain that for many generations to come there will be a need for the very best talent and enterprise in the electrical profession. The book contains a brief review of the past history of electricity, describes its various aspects at the present day, and gives advice on foundation studies and training for a career in one of the many branches of electrical engineering.

*Swords into Ploughshares

Hints on the adaptation of "surplus" war material for model engineering or utility purposes

Electrical Measuring Instruments

by " Artificer "

By far the great majority of instruments now offered for sale on the surplus market embody moving-coil movements in some form or other ; in many cases these are beautifully made, with jewelled or highly-finished pivot bearings, and extremely sensitive, yet at the same time much more robust than most instruments designed for laboratory work. The latter property is, of course, a sheer necessity for instruments which have to be carried in tanks, naval ships and aircraft, and a good deal of research work has been devoted to the development of " shockproof " instruments and resilient mounting devices for this purpose.

Mention has already been made of the instruments employed as indicators for remote-reading electric thermometers, tachometers, etc. In the thermo-couple type of thermometer, a straightforward type of moving-coil millivoltmeter is used for this purpose, in conjunction with a simple copper-constantan thermo-couple. (" Constantan " is a special alloy which has been developed for electrical purposes, the salient characteristic of which is that its coefficient of resistance in relation to temperature is substantially constant over a wide range ; it is extensively used as one of the elements in thermo-couples for temperature measurements.) The wiring diagram for an electrical thermometer of this type is shown in Fig. 7, and the movement of the instrument, illustrated in the part-sectional view (Fig. 8), is a straightforward moving-coil movement having a circular permanent magnet and a single coil winding, which is generally calibrated to give the required scale reading, on the potential generated by the thermo-couple, without the need for an additional calibrating resistance in series. A device for compensating temperature changes in

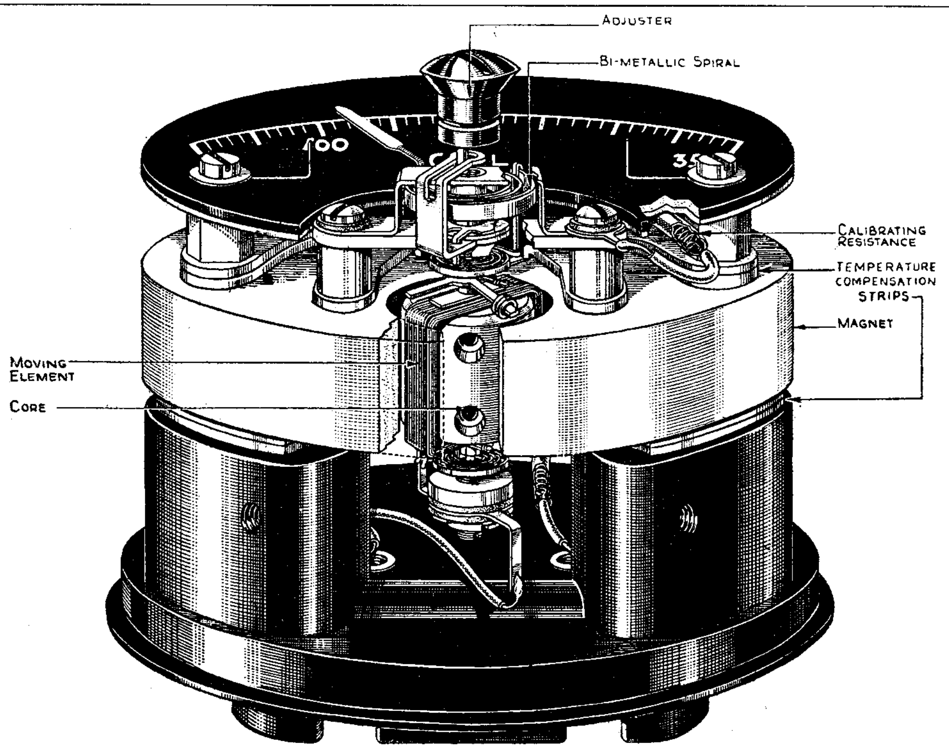


Fig. 8. Movement of millivoltmeter used in connection with thermo-couple

*Continued from page 493, " M.E.," May 6, 1948.

the instrument itself is provided, in the form of a bimetal spiral, one end of which is secured to the frame of the movement, through a pre-setting adjustment, while the other is attached to the anchorage of the return hairspring. Instruments of this type are used for moderate to fairly high temperatures, up to about 350 deg. C.

Another type of electrical thermometer, which has also been briefly mentioned in previous articles, depends upon the use of a resistance which is extremely sensitive to changes of temperature; unlike the alloy "constantan," mentioned above, the metal selected for the resistance is one in which the resistivity increases rapidly as the temperature is raised. In this case the element is not self-generating, but must be energised from an outside source of supply, usually a battery. If the potential of the latter could be maintained absolutely constant, it would be possible to use a straightforward single-coil indicating instrument, as in the preceding example. But in practice, some variation of battery voltage is inevitable, and to obtain accurate readings of differences in the resistance of the heat-recording resistance, due to temperature variations, it is necessary to use a special form of indicating instrument, known as a "ratiometer"; the theoretical circuit of the system is illustrated in Fig. 9.

This instrument is of the moving-coil type, but instead of the usual single coil on the moving element, it has two coils, wound at an angle to each other and in opposite directions, so that each tends to cancel out the effect of the other. The design of the magnet pole pieces and core is arranged to produce the required characteristics of movement and scale reading. When the current flow through each coil is equal, a state of balance is produced, but any difference in the current in the two coils unbalances them and causes a movement of the pointer.

Current is led into the coils, through a limiting resistance, to the return hairspring which serves as a common lead-in, but the other ends of the coils are separately connected, through flexible connectors or "ligaments," to calibrating resistances. One coil circuit is connected in series with the heat-recording resistance, and is thus subject to alteration in the flow of current as the temperature of the latter varies; the other coil circuit is fed directly from the battery, and serves as a "comparator."

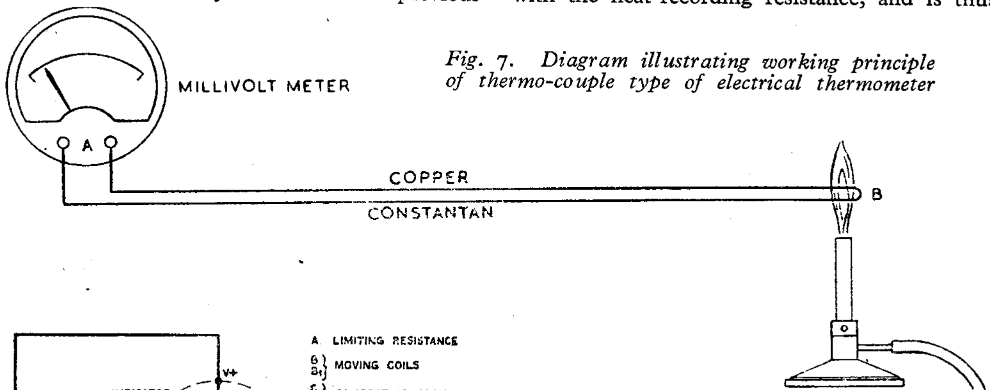


Fig. 7. Diagram illustrating working principle of thermo-couple type of electrical thermometer

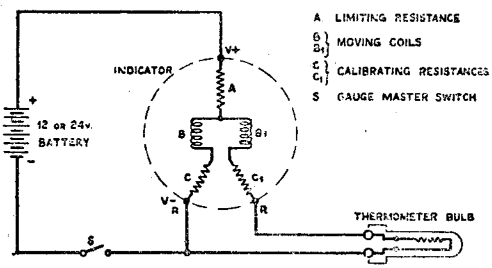


Fig. 9. Theoretical circuit of resistance-type electrical thermometer

These instruments are highly sensitive, and are used mainly for recording small increments of temperature, especially at the lower ranges, from − 20 C. upwards, though some of them may read as high as 200 C. The movements are sometimes duplicated, either by using a single permanent magnet with two moving elements, or two separate movements in a single case; an example of such an instrument is shown in Fig. 10.

Duplex moving-coil instruments are employed for several other purposes, including indicating instruments for use in connection with "beam" landing systems, an example of which is shown in the photograph on this page. This is not fitted with a calibrated dial, but the movement of the left- and right-hand pointers indicate any deviation of the course of the aircraft from the direction of the radar beam.

Another example of a dual moving-coil instrument is that illustrated on page 490 of the May 6th issue, which represents the speed indicator for two aircraft engines, to work in conjunction with direct current generators of the Air Ministry Mark II type, as illustrated on page 216 of the Feb. 26th issue. A hermetically-sealed metal case is provided to house the two movements, with a glass panel in front of the scales, which are located so that the pointers swing in a vertical arc. The movements are large and robust, and would serve excellently as a nucleus for a universal laboratory test instrument. Both shunt and series resistances are incorporated so that both the current and voltage outputs of the generator are utilised to produce the required characteristics of scale reading.

Recalibrating Moving-coil Instruments

The methods of recalibrating instruments of

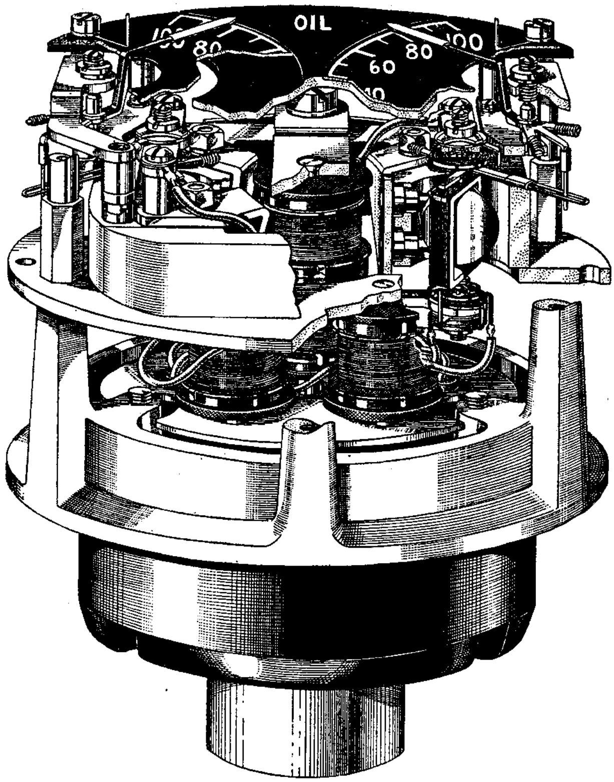


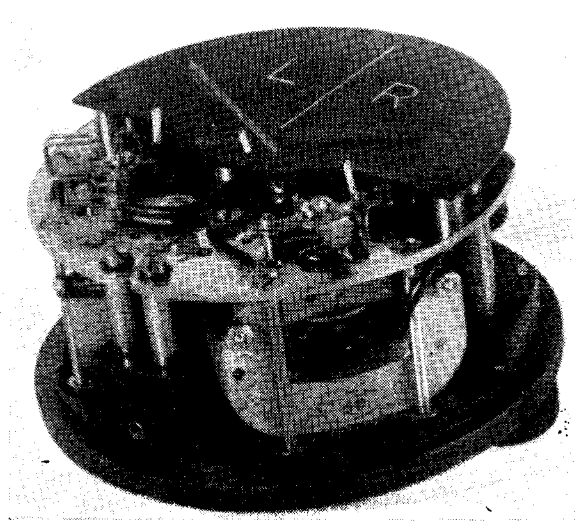
Fig. 10. *Double-pointer movement of Ratiometer-type electrical thermometer*

the fixed coil type have already been referred to. In cases where these do not incorporate calibrating resistances, it is usually quite convenient to rewind the coils, on the principle that the force exerted in deflecting the needle or armature will depend upon the product of the current and the number of turns in the coil—in other words, the simple "ampere-turns" rule. But with moving-coil instruments, it is not generally practicable to rewind the coil, and recalibration must be carried out by the application of shunt or series calibrating resistances.

It is immaterial whether the instruments are originally calibrated in electrical or other terms, though in the former case, it is often practicable to alter the range by multiplying or dividing by ten, so that the figures on the scale only need altering by adding or shifting a decimal point.

In the laboratory testing and calibration of instruments, it is usual to employ "absolute" standards of measurement, involving the use of standard fixed resistances, constant voltage supply, and Wheatstone bridge or similar methods of circuit balancing. If, however, the experimenter is in the fortunate position of having apparatus of this nature available, it is more than probable that he will be familiar with its use, and require little guidance from these articles. The majority of readers for whom these hints are intended will have little in the way of specialised knowledge or equipment. If it is objected that the methods to be described are somewhat rough-and-ready, or in other words unscientific, the excuse is that they are easily applied, and will serve the purposes required of them by most readers. As already explained, the commercial standard of accuracy in moderately-priced instruments is often far from perfect, and readers should find little difficulty in equalling it.

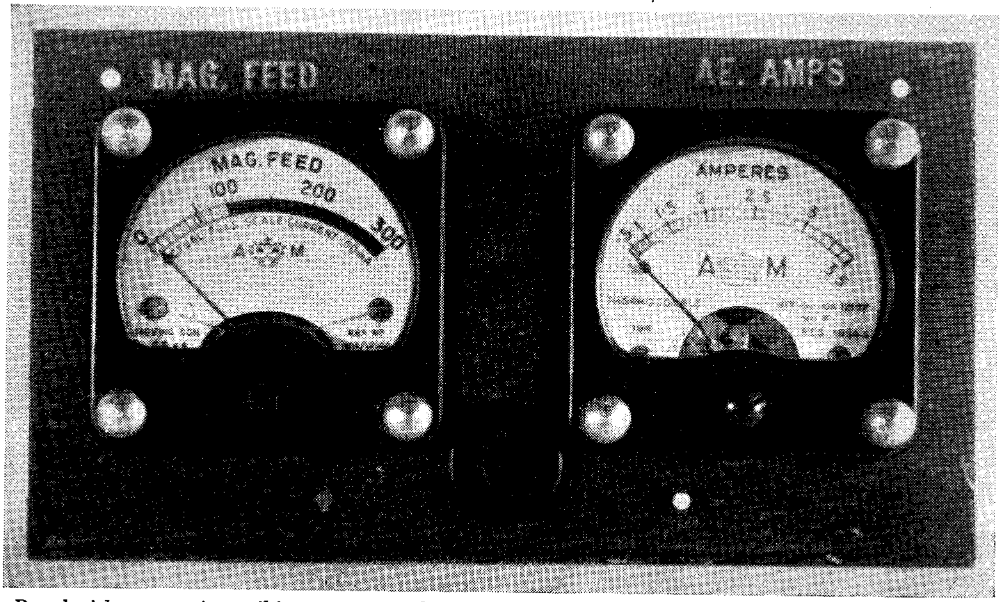
For the purposes of test and recalibration to be described, it is necessary to have available, a fairly accurate test instrument capable of dealing with the range of current or voltage for which the instrument is to be calibrated. If possible, a multi-range test instrument, such as the well-known "Avometer," should be employed. It may be mentioned that some of these instruments are now to be found on the surplus market, and a simplified version of the above, the "Avominor," can be obtained, complete in leather case with test leads, clips and prods,



Double-pointer indicating instrument as used in "beam" landing gear (H. Franks)

for £3 10s. A variable rheostat or potentiometer is also necessary, and a source of current supply, which may be in the form of small dry cells or accumulators.

It is first of all necessary to ascertain the current carrying capacity and resistance of the movement, when stripped of all shunt or series resistances; in most cases, this will be very low, and therefore only small increments of current or voltage need be applied. Assuming that the instrument is to be calibrated for current measurement, it should be connected in series with the test instrument, and current cautiously applied using a single cell and a high resistance to begin with; the connections must, of course, be arranged to produce correct polarity. It is assumed also that the movement is in good condition both electrically and mechanically, and that the element swings quite freely. Sometimes instruments become clogged with dust or metallic particles such as iron filings, which have a passionate affinity for magnetic fields.



Panel with two moving-coil instruments, calibrated as a milliameter and thermo-ammeter respectively. (H. Franks)

The amount of current necessary to produce full-scale deflection (or some definite movement) of the pointer, as indicated by the test instrument, will give a good idea of its resistance and "natural" range. Assuming that it requires a current of 0.1 amperes, on an application of a 2-volt battery, to produce the given deflection, the resistance, according to Ohms law, will be 10 ohms, and the natural range of the movement (i.e. without addition of calibrating resistances) will be 100 milliamps.

This, however, represents the resistance of the entire test circuit, including the test instrument, the rheostat, and the internal resistance of the battery. To obtain the true resistance of the movement with the minimum error, the actual voltage drop across its terminals should be measured while under test. But it is not absolutely essential to know this figure, so long as some idea of it is obtained.

Assuming now that it is desired to calibrate the instrument to read to a maximum of 5 amperes; it is then necessary to arrange a shunt resistance across the terminals of the movement, so that the total resistance through the instrument circuit will be $\frac{0.1}{5} = 1/50$ of that of the movement alone. Taking the resistance figure of 10 ohms for the movement, this will be $\frac{10}{50}$ or 0.2 of an ohm, and the shunt should therefore be approximately of this value—actually a little higher, as it is subtracted from the resistance of the movement. It is extremely difficult to measure such low resistances, and will therefore be more convenient to find the value by trial, checking up on results with the test instrument as before. The most convenient form of shunt is a strip of copper or German silver of appropriate gauge and width; this has the advantage that fine adjustment may be made by filing the edge of the strip as required. If any soldered connections are used on the strip, they should be made before final measurements are taken, as they may modify the value of the shunt.

In the event of instruments required for voltage measurements, the same general principles of calibration are employed, but the calibrating resistance is added in series with the movement, and the comparator instrument is connected in parallel. The value of the resistance is also very much higher, and its most convenient form is in a coil of very fine insulated resistance wire such as Eureka or Manganin alloy. This wire may be

difficult to obtain at present, but many of the instruments available already contain bobbins wound with suitable wire which may be utilised.

If the same movement as that already considered is to be calibrated as a voltmeter, to read up to a maximum of, say, 10 volts, it will obviously be necessary to increase the total resistance in the ratio of five times, to obtain the same reading as that originally produced by 2 volts. The total resistance required, therefore, will be 50 ohms, and as 10 ohms are already accounted for in the movement, the series resistance will need to be 40 ohms. Other ranges of either current or voltage measurement are readily found by the application of simple arithmetic, but some fine adjustment will always be necessary if one wishes to preserve exact ratios of scale movement ; in the case of series resistances, a few turns may be added to or subtracted from the bobbin for this purpose.

When the instrument is not originally calibrated in electrical terms, and even in some cases when it is, the marking of an entirely new scale, or of the figures thereon, may be found necessary. The increments of pointer movement corresponding to current or voltage should be carefully checked by comparison with the test instrument, and fine pencil marks made on a temporary paper scale, which is subsequently copied on a metal, ivorine or celluloid scale, and engraved or inked in. The neatness and accuracy of the final result will depend largely on one's skill in draughtsmanship, but a very neat and " professional " appearance may be produced by copying the scale exactly in true proportion but several times larger, in Indian ink on Bristol board, and photographing it. A highly-glazed print is then obtained, taking care to produce either in the negative, or by projection printing, exactly the size of the actual scale.

Given a really accurate and sensitive movement, such as are quite readily obtainable in surplus instruments, it is not beyond the ability of the amateur to produce his own multi-range test instrument, by preparing the required number of calibrating resistances, and a suitable system of switching. For measuring resistances, it is usual to employ a constant-voltage cell, and a movement calibrated to give full-scale deflection when shorted across the cell. Calibration in terms of ohms resistance is then most readily obtained by using a standard test resistance box ; the reading on the scale is, of course, in the reverse direction to that of ammeters and voltmeters. The value of a carefully-made compound instrument of this type may be as many pounds as the shillings expended on the essential materials of its construction.

(Diagrams and cutaway views of instruments are reproduced by courtesy of Smiths Aircraft Instruments Ltd.)

(To be continued)

Editor's Correspondence

" Factory Methods in the Home Workshop "

DEAR SIR,—May I write to congratulate " 1121 " on his excellent notes on the above subject, with particular reference to the back-parting tool described. The design of the tool post is a fine combination of efficiency and economy.

I should like to comment a little on the use of such a post. He describes the machining of a set of bushes, and at the end, reverses them in the chuck to finish to length. If the component is of large diameter in relation to length, it may be quite difficult to set it in the chuck so that the faces are parallel. For example, about three years back, in the shop where I am employed as an inspector, there were a number of brass spacers to be made $\frac{3}{4}$ in. diameter, $\frac{1}{4}$ in. reamed bore and 0.500 in.-0.003 in. thick. The original layout was face, drill, ream, part off + 1/64 in., reverse and face to length. It proved impossible to be sure of that 0.500 in.-0.003 in.

It was finally managed by careful setting of the facing and parting tools in relation to each other and parting off to finished length at the first operation.

I have also seen the same arrangement used to machine both faces of a bolting flange on a cylinder. The spacers mentioned were machined on a 2A Ward lathe, which is not quite the same as the 4 in. Drummond which is " 1121's " pet, and mine.

I don't know how much difference that would make. Anyway, I propose to try machining some Gauge " O " carriage wheels from brass bar at one operation, with the aid of a similar set-up.

The only point in the scheme that I am doubtful about at the moment is drilling for the axle. I haven't a centre drill just right and a twist drill is liable to wander. Is it practicable to make a D-bit to drill 0.103 in. diameter by $\frac{5}{16}$ in. deep at one operation, without the bother of changing drills for each component ?

Yours faithfully,

Rugby. JOHN H. REYNOLDS.

Hot-Air Engine Cycles

DEAR SIR,—Mr. Wrangham is most interesting and informative on Hot-Air Engine Cycles, but may I beg to point out that thermal efficiency is no criterion of power output where the source of heat is comparatively unlimited.

For example, Stirling's regenerator undoubtedly conserves heat, but is the air that has passed through it reduced as much in temperature as the air which passes the displacer walls close to a cold outer cylinder ?

I am sure not, and to obtain maximum power we require maximum *variation* in temperature, even if we have to achieve it by ruthlessly discarding heat at the right moment.

The thermal efficiency of many small power engines must be very low indeed, such as motor-cycle engines. I have never seen it quoted, but I doubt if it reaches 10 per cent.; nor does it appear to be considered, for the sole aim and object seems to be to get as big a charge of optimum fuel mixture as possible burnt in the cylinder in the minimum of time, in order to obtain maximum ft./lb. per minute. After all, is not an I.C. engine simply an "open cycle" hot-air engine that uses the most efficient means possible of heating the charge of air? Note also that high compression prior to heating is essential to its power output, as it is in the turbo-jet engine.

This substantiates the theory of an earlier writer in THE MODEL ENGINEER, who advocated a hot-air engine working with a charge of several atmospheres pressure, and is, in my opinion, the only way of deriving a worth-while power output. Its thermal efficiency may be less than ever and its indicator diagram a nightmare to the thrifty-minded; but if it "does the knots," who cares?

Yours faithfully,

Barton. F. O. BROWNSON.

Club Announcements

City of Leeds Society of Model and Experimental Engineers

The above society are to hold the undermentioned meetings in their usual meeting places, the Salem Chapel and Mr. Cook's Signwriters' Works.

We no longer meet at Hayes Engineers Ltd., all meetings being carried out at the Salem Chapel and Mr. Cook's workshop.

Members were taken on a tour of Leeds G.P.O. on April 12th, a very interesting two-and-a-half hours being spent in the various departments.

A very nice evening was spent on April 15th., Mr. Hainsworth and his new cinematograph projector being the entertainment. This is a remarkable job, everything being made by Mr. Hainsworth, except the lens of course, although the condenser was ground and lapped by hand.

Brazing, too, has been very much to the fore, Mr. Hainsworth again doing the needful.

Thursday, May 20th. "Bits and Pieces Night"—Salem.
Thursday, June 3rd. Open meeting at Salem.
Tuesday, June 8th. Brazing evening at Mr. Cook's.
Thursday, June 17th. Lecture at Salem on "Locomotive Boilers" by Mr. Burton of British Railways Works, Doncaster. Illustrated by lantern slides.
Tuesday, June 22nd. Visit to Mr. Kilburn's 5-in. gauge railway at Ilkley.
Thursday, July 1st. Open meeting at Salem.

All the above meeting start at 7.15 p.m. and all interested are invited to attend.

Hon. Secretary: R. G. COLBRAN, 9, Church Wood Avenue Headingley, Leeds, 6.

Willesden and District Model Engineering Society

The above society is now firmly established with a small but keen membership. We are, however, anxious to obtain more recruits for both the power boat and aeronautical sections. Applications are, therefore, invited from local model engineers who desire to become members. Our meetings are held on the dates set out below at the Brondesbury Park Congregational Church Hall, Wrentham Avenue, Kensal Rise, N.W.10.

May 26th. Open meeting.
June 9th. "Cabinet Making." Mr. G. H. Saggers.
June 23rd. Open meeting.
July 7th. "Sheet Metal Work, Welding and Brazing." Mr. L. H. Smith.
July 21st. Open meeting.
August 4th. "Founding a Model Engineering Business." Mr. Stacey.
August 18th. Open meeting.
September 1st. "Turning and Precision Honing." Mr. A. E. Rawlings.

Hon. Secretary: E. J. OAKERVEE, 92, Harvist Road, Kensal Rise, London, N.W.6.

West Sussex Model Engineering Society

An active year, including an exhibition to which some 1,000 had paid to see, was reported by our chairman, Mr. C. P. Philo, at our first annual general meeting held on Friday, April 9th.

Through the good offices of Dr. Greenway and the Bognor Regis hospital authorities, we now have the use of our present headquarters—No. 48, Chichester Road. The premises have been "licked into shape" and a workshop, library, canteen, reading room, carpentry room, etc., installed.

The new club rooms are open to members on Tuesday and Friday evenings from 7.30 p.m. to 10 p.m. and any other nights by arrangement with a committee member. New members and visitors are welcome, and it has been decided to form a junior section of the society for serious modellers between the ages of 12 and 16.

Secretary: B. A. MOSES, 14, Clifton Road, Bognor Regis.

City of Bradford Society of Model and Experimental Engineers

May 20th. Thursday evening, 7.15 p.m. At Laycock's Rooms. Demonstration by A. Barber of making, hardening and tempering, small drills, taps, reamers, spiral and flat springs, milling cutters and circular files for use in lathe and drilling machine, etc.

May 22nd. Saturday afternoon, 2 p.m. At the Works. A visit has been arranged to the City of Bradford Corporation Sewage Works at Esholt.

Hon. Secretary: W. WOOD, 274, Hunsworth Lane, Cleckheaton.

Salisbury and District Model Engineer Society

Great progress is being made by the above society, which has more than doubled its membership in recent weeks. An aircraft section has been formed with its own committee, officials and timekeepers, who will arrange flying contests and other activities for the aeromodellers. We are now affiliated to the S.M.A.E.

Much interest has been aroused by a show of model aircraft in the window of the local R.A.F. Recruiting Centre. A show of engineering and scientific films will be given at the British Legion Hall on May 21st, to which members of the public are invited.

The society has also decided to hold a model engineering exhibition in Salisbury in July—the first to be organised by the society and probably the first ever to be held in Salisbury. It is hoped to have a comprehensive show of models, several of which will be working, and if possible to arrange to have a miniature passenger carrying railway in operation.

Members of H.M. Forces stationed in the district who are model engineers are now eligible for membership, paying a reduced subscription.

Full details of the society's activities and forms of application for enrolment may be obtained of the Hon. Secretary, R. A. READ, 7, De Vaux Place, Salisbury.

NOTICES

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. **All such correspondence should be addressed to the Editor (and not to individuals)** at 23, Great Queen Street, London, W.C.2. Matter intended for publication should be clearly written, and should invariably bear the sender's name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

All correspondence relating to sales of the paper and books to be addressed to THE SALES MANAGER, Percival Marshall & Co. Ltd., 23, Great Queen Street, London, W.C.2.

Correspondence relating to display advertisements to be addressed to THE ADVERTISEMENT MANAGER, "The Model Engineer," 23, Great Queen Street, London, W.C.2.